Editorial & Publishing Offices :
MACMILLAN & CO., LTD.
ST. MARTIN'S STREET
LONDON, W.C.2

Telegraphic Address :
PHUSIS, LESQUARE, LONDON

Telephone Number :
WHITEHALL 8831

Vol. 144 SATURDAY, SEPTEMBER 23, 1939 No. 3647

SOCIOLOGICAL ASPECTS OF EVACUATION

THE complaints which are being received regarding the operation of evacuation schemes in England have at least the merit of preventing any undue complacency arising from the smoothness and efficiency with which the actual transport arrangements were carried out. The success of that operation and its fortunate freedom from attack might well have engendered undue optimism and encouraged the tendency to forget that the real test of evacuation has yet to come. The problem of dispersal, however urgent as a first step in national defence, is simple compared with the more abiding social problems which evacuation presents, not only under emergency conditions but also in the permanent re-integration of national life.

It is well to recall at the start that, as Dr. T. Adams pointed out in his able paper at the British Association meeting at Dundee, under certain conditions, evacuation, however difficult and costly, must remain for some few cities an indispensable element of defence while the possibility of war remains, unless we are prepared deliberately to forgo certain of the advantages which can only be realized in a properly administered city. Accordingly it is important that the experience gained at every stage from the actual preparation and conduct of the evacuation, to arrival and settlement in the reception areas, the social problems of the evacuated areas, until the final return to and re-settlement in the evacuated areas when the emergency has passed should be carefully sifted and studied by scientific and impartial minds.

The outstanding feature of evacuation in England is indeed that it is a social experiment on a very large scale, and its success or failure will depend on the attention which is given to the social factors, and the thoroughness and impartiality with which they are investigated and handled. It should be obvious that many of the well-founded complaints which are encountered arise primarily from neglect of, or imperfect attention to, social factors in the preparation for the dispersal. Certain misfits or embarrassments were almost inseparable from a domestic re-shuffle on the existing scale. Differences of outlook and of social position must be expected and should provide no insuperable bar to domestic harmony. Different conceptions of what constitutes personal cleanliness present much more intolerable difficulties, and complaints on this score have come as freely from those acting as hosts as from evacuees who shrink from the squalor of the homes in which they have been placed.

The extent to which such complaints have been voiced is clear evidence that something has been seriously amiss with the planning of the evacuation. Insufficient attention has been paid to the relative social types of evacuating and receiving areas. In some instances accommodation of the exact type required has been untapped while the evacuees were received into neighbouring districts under conditions which promptly stimulated a migration homewards. The veriest attempt at social survey or comparison of receiving and evacuating areas would have greatly reduced the proportion of misfits.

It should not, of course, be too late to remedy the worst mistakes, and indeed certain education

authorities have taken wise and effective action. Too much stress cannot be laid on the importance alike of checking any homeward drift and of encouraging the good will between the evacuees and their hosts which is generally so conspicuous a feature. The value of this sympathy and understanding can scarcely be overstressed in relation to the social re-integration which lies ahead.

That is the aspect upon which attention should next be concentrated, and the reopening of the schools and development of the educational organization in the reception areas is only a special aspect of this problem. Difficulties raised by such questions as equipment and buildings are of secondary importance compared with that of ensuring that the evacuated children are living in a background favourable to their development, and repairing so far as possible the damage which upheaval and separation from homes and parents and familiar surroundings may have engendered.

If it is necessary to plan for a period of three years or more, as indicated by the Government, something more than temporary expedients will be required, whether in regard to educational equipment or social background. Moreover, the drawbacks of improvisation in teaching are all the greater if the satisfaction and support which the normal home surroundings afford are lacking. Equally the social services which the development of education has been rendering may be even more imperative under the conditions which obtain in the reception areas if the nation's capital in youth is not to be wasted.

To maintain existing standards of education and well-being among children and adolescents in the conditions imposed by evacuation is no simple problem, but its solution is essential, and no exigencies of national defence can justify its neglect. Indeed, the experience of the War of 1914-18 should remind us of the danger of abandoning policies already laid down for improving those standards. It is not to be expected that no checks will be encountered or no harm done under the conditions of strain and hazard imposed on the whole nation; but there is no more vital national interest than that of seeing that the young are shielded from any untoward effects so far as possible, and the disturbance of their normal development and training minimized.

The educational problem is only one of the issues raised by evacuation, and even here there are features which may yet prove to be assets. To thousands of children from congested areas and slums a new world is opening, and the spirit of adventure in which they set out at least holds promise of an opportunity of bringing townsfolk to learn something more of the countryside and of its life which could give a new meaning to some of the content of educational syllabuses. The spirit in which most people in the reception areas have accepted their responsibilities and the courage and adaptability of most adult evacuees are other solid assets that have not only made the evacuation scheme workable but also helped to alleviate the wholesale disruption of family life entailed.

The opportunity of social re-integration must not be missed, and the good will displayed in the actual evacuation cannot be allowed to be dissipated. Steps must be taken to mitigate and to eliminate the disruption of family life so far as possible and to explore rapidly all avenues, such as the construction of rural camps which offer the prospect of terminating the separation of mothers and children. Besides this, problems of health and hygiene will demand close attention if the dangers of epidemics, especially under the stress of emergency conditions, are to be prevented or minimized, and excessive strain on health, sanitation, water supply and other public services in the reception areas avoided.

Many of these matters call for wise planning and scientific investigation; but no complete solution can be achieved if we fail to remember that the problem is a national one and not merely that of a number of independent reception areas. The evacuated areas themselves will be subjected to economic and social stress and strain even if fortunately spared from actual attack from the air. Not merely private households, but also general trading conditions, amenities and public services cannot but be profoundly affected if not dislocated by the removal of a high proportion of the population of an area.

The economic problems of evacuation are large and complex. No less important are those of recreation and fitness. These reach far beyond the provision of facilities for organized games for the schools in the reception areas. The existence of amenities for physical and mental refreshment is a vital factor in the psychological adjustments involved and in the maintenance of morale.

The psychological aspects of evacuation are possibly the most important of all. Neglect of them may delay the establishment of reasonably

satisfactory conditions in reception and in evacuated areas. At the worst it may lead to deterioration in morale, which by frustrating the very purpose of evacuation may endanger the whole national effort. The stresses set up both in evacuation and in reception areas, like those caused through the whole fabric of civil life by the necessity of re-adapting or even re-orientating life to the restrictions of movement, lighting, etc., imposed by wartime exigencies, and the strain of long hours, often with responsibilities in some branch of civil defence in addition to the working day, demand some opportunity for relief from time to time if serious physical or psychological damage is not to result.

On this ground alone the question of recreation presents problems which cannot long be neglected. Means must be found, consistent with public safety, of ensuring reasonable opportunities of entertainment and relaxation. Possibly the transfer or redistribution of such facilities in the reception areas may be involved as part of the policy of developing an adequate communal life. It should not be forgotten, however, that the migration to the reception areas has, together with the curtailment of public and private means of transport, largely closed for purposes of recreation areas which derive most of their importance from their value as health resorts. As the war continues, the need for attention to such questions cannot but increase.

These are only some of the more immediate problems which evacuation presents. There are others equally important which will require attention before the normal trend of the national life can be resumed. The dispersal of business and industrial firms as well as of Government departments and the accompanying decentralization will raise questions of policy before a return can be made to previous locations. New and unexpected opportunities of town planning and of guiding the location of industry may well present themselves, if the experience now being gained is wisely utilized. In these, as in the more immediate and pressing problems, impartial survey and patient scientific investigation of the many economic, social, technical and psychological factors involved are essential. Scientific workers would be unworthy of their own traditions if they failed to insist on the importance of a scientific study of the problems which evacuation presents, or to direct attention to factors which threaten to sap either the physical or the moral welfare of the nation in the task to which it is now addressed.

FLUID DYNAMICS

Modern Developments in Fluid Dynamics

An Account of Theory and Experiment relating to Boundary Layers, Turbulent Motion and Wakes. Composed by the Fluid Motion Panel of the Aeronautical Research Committee and others, and edited by S. Goldstein. (Oxford Engineering Science Series.) Vol. 1. Pp. xxiv + 330 + 29 plates. Vol. 2. Pp. xii + 331–702 + plates 30–35. (Oxford: Clarendon Press; London: Oxford University Press, 1938.) 50*s*. net.

THE present work is dedicated to the memory of Horace Lamb, the father of classical dynamics, whose fundamental work, "A Treatise of the Mathematical Theory of the Motion of Fluids", appeared in six English editions as well as in several foreign translations and is in the hands of every specialist in the theory of fluid motion. By 'classical' hydrodynamics, we understand the hydrodynamics of the nineteenth century in contrast to that of the twentieth, which is distinguished chiefly by a more detailed and at the same time extensive study of the influence of viscosity, particularly in the case of fluids of small viscosity, so that a much nearer approach to reality has been attained. Even those parts of the modern theory which are fundamental for the ideal frictionless fluid have been enriched in very important points by new research. Here, the knowledge of the existence and behaviour of surfaces of separation was effective in the discovery of new ways in which to obtain practical results.

During the last twenty years, much new knowledge, with practical applications, has matured concerning the disturbance occurring in the majority of technical fluids—of which the ultimate cause is still a problem—which is known as turbulence. These developments have proved extremely fruitful where scientific application is

concerned, as, for example, in meteorology and oceanography.

The great interest which has developed in recent years in aeronautical science, for which fluid theory is of basic importance, had considerable influence on the rapidity of progress in the science of hydrodynamics. In consequence, research in the subject has advanced at such a pace and has given rise to such an immense literary output, that it has become increasingly difficult for any one individual to keep up with it. Hence a number of works of a co-operative nature have appeared in which the attempt is made to present a survey of all the results obtained by research. Two earlier works of this kind are "Handbuch der Physik", Vol. 8 (1927), by Geiger and Scheel, and "Handbuch der Experimentalphysik, Vol. 4 (I–IV, 4 (1930–1932)). A newer work in six volumes, entirely devoted to aerodynamics, is "Aerodynamic Theory" (1934–1936), by W. F. Durand.

Although the present work is distinguished from previous ones by its intentional limitation to particular fields which are intimately connected with one another, the sections in themselves are amazingly comprehensive. For this reason alone, the book is certain to remain for a long time indispensable to the further development of research in these fields. A characteristic of the whole domain with which this book is concerned is that it includes those branches of hydrodynamics and aerodynamics which are concerned with viscous fluids and particularly those possessing low viscosity, or, in other words, with laminar and turbulent flow, with special consideration for flow near the surfaces of solid bodies and in the domain of great turbulence behind them. Furthermore, the transference of heat in laminar and turbulent fluid motion is considered. On the other hand, neither potential fluid motion, nor the three-dimensional aerofoil theory, nor the propeller theory are dealt with. Nor indeed do the problems of compressibility and cavitation come under consideration.

The contributors to this work include members of the Fluid Motion Panel of the Aeronautical Research Committee, of which Sir Horace Lamb was a member for many years and which now includes eleven British research workers and four younger workers. It is a truly co-operative work in which even the names of the authors are kept well in the background. In fact the only name which appears is that of the editor, Dr. S. Goldstein, who directed the research and writes an introduction for the benefit of the reader, in which the most important concepts in hydrodynamics are expounded in a brief but extraordinarily clear manner.

The contents of the book are arranged as follows. Of two introductory sections, the first is concerned with fundamental concepts and with the laws of motion of the ideal non-viscous fluid, and the second with laminar and turbulent boundary layers and their effect with regard to drag. In the third section, a strict mathematically formulated account of the laws of viscous fluids accompanied by accurate solutions of the equations is given. The fourth section expounds the mathematical theory of fluid boundary layers, the fifth is devoted to the concept of turbulence, while the sixth discusses experimental apparatus of all kinds (wind tunnels, experimental tanks, whirling arms, velocity and pressure measurements, visualization of fluid motion). In the seventh section as well as in the eighth, with which the second volume begins, fluid motion in pipes and canals and along level plates, obedience to the law of the laminar and turbulent forms of motion together with the relation of the former to the latter, are very thoroughly expounded. In Section ix the problem of resistance in the case of symmetrical cylinders is discussed, while Section x is concerned with the resistance of asymmetrical cylinders and special aero-foils; in Section xi rotation shapes (airship shapes) are considered. The different kinds of control of boundary layers are examined in a further section, which is followed by another to consider events taking place in the wake of a moving object. The final sections, xiv and xv, are concerned with heat transfer by conduction and convection in laminar and turbulent fluid motion.

The excellent illustrations are a special feature of the work. Wherever possible they are taken from original monographs, and the photographs—the majority from the original—are excellent half-tone prints reproduced in thirty-five plates. This natural documentation increases the interest of the book and is very welcome. Furthermore, the value of the work, which is carried out most conscientiously in all sections, is much enhanced by very complete author and subject indexes covering twenty-two pages. The reviewer noted with great appreciation that not only important English works on the subject, but also all those known to him in the foreign literature also are included. There is no doubt that this work will contribute enormously to the furtherance of research in the subjects with which it deals and that it will be of inestimable use to students.

The reviewer would like to make one suggestion, namely, that short explanatory legends under the illustrations—which are absent in this work—are very helpful to those who have not studied the text of the book itself. Such explanatory legends are particularly helpful when one is glancing through the book for the first time. L. P.

SYMBIOSIS BETWEEN FUNGI AND SCALE INSECTS

The Genus Septobasidium

By Prof. John N. Couch. Pp. ix + 480 + 114 plates. (Chapel Hill, N.C.: University of North Carolina Press; London: Oxford University Press, 1938.) 5 dollars.

UNDER the able leadership of Prof. W. C. Coker, the Botanical Department of the University of North Carolina has produced several major works on fungi: "The Saprolegniaceæ, with Notes on other Water Molds" (1923); "The Clavarias of the United States and Canada" (1923); "The Gastromycetes of the Eastern United States and Canada" (1928); and "Studies of the Genus Pythium" (1931). To these there has recently been added John N. Couch's splendid monograph on the genus Septobasidium.

By means of sucking tubes, scale insects obtain their nutriment from the cambial region of the plants to which they become attached. Von Hörnel and Litschauer in 1907 were the first to direct attention to the remarkable fact that, in the dried species of Septobasidium investigated by them, scale insects are always present under the hyphal mats formed upon the bark of twigs or branches. Couch, working for more than ten years on living material, has now shown that scale insects are present in the hyphal mats of Septobasidium species in general and that the fungi and the insects live together symbiotically. A Septobasidium can extend its development only in connexion with scale insects, and when these insects die the growth of the fungus ceases. The insects are protected from their enemies by the fungus, and the fungus draws its nutriment from, and is distributed by, the insects. The symbiotic relationship of the fungi and their associated insects has been discussed by Couch in detail.

In *Septobasidium Burtii*, the life-history of which Couch describes and illustrates very fully, the fungus mat above an insect's body on an oak branch is nowhere in direct contact with the insect, but the two are connected together by numerous coiled hyphæ. This arrangement gives the insect freedom of movement to breathe, so that it will not suffocate. The coiled hyphæ are attached to the insect at the dermal pores and setæ. By means of the threads passing through the natural apertures of the insect's body-wall the haustoria of the fungus within the insect's body are connected with the mat and thence with the other parts of the fungus. The haustoria are found only in the circulatory system or hæmocœl of the insect, and they are coiled in form.

With the help of the haustoria, the fungus obtains the nutriment necessary for its growth and for the production of basidiospores on its exterior surface. Not all the insects beneath a stroma are parasitized, but those that are are dwarfed and incapable of reproduction. The young insects are infected by bud cells formed by the spores and never by fungal hyphæ. Some of the insects which have become infected by crawling over the spore-bearing surface may crawl back beneath the fungus colony under which they were born, others may settle down beneath other fungus colonies, and some settle down on the bare bark. The first two groups of insects are solely responsible for the survival and continued growth of fungus colonies, while the third group, which settle down on clean bark, are solely responsible for the distribution of the fungus. Under natural conditions, whereas the fungus cannot live without the insects, the insects are able to live without the fungus; but the life of insects unprotected by the fungus is precarious.

Septobasidium is widely distributed in the world. There are numerous species in the United States, the West Indies, Brazil, Ceylon, Java, and the Philippine Islands, and a few species have been found in Europe and Australia.

By far the larger part of the volume is devoted to taxonomy. On the basis of the symbiotic relationship, Couch has raised the Septobasidiaceæ to the rank of an order, the *Septobasidiales*, co-ordinate with the Auriculariales, the Uredinales, and the Ustilaginales. A key for identification is followed by a description of 163 species, 5 varieties, and 2 hybrids. Some 56 species are described as new.

The illustrations are numerous and admirable. Among other things they depict: the insect houses and their occupants; the relations of the fungi and insects with one another and with the tree at the expense of which they both ultimately live; the ways in which the fungi extend their colonies by the capture and infection of more and more young insects; and the microscopic details of structure of nearly all the species of Septobasidium which have been described.

Prof. Couch is to be heartily congratulated on the outcome of his labours. By long-continued and exact observation he has added greatly to our knowledge of Septobasidium species, and at the same time he has made a series of beautiful discoveries concerning the relations of fungi and insects. His book is a valuable addition to biological literature, and its contents will appeal not only to mycologists but also to entomologists and naturalists in general. A. H. REGINALD BULLER.

SPECTROSCOPY IN INDUSTRY

Spectrographic Analysis in Great Britain
Edited by A. C. Candler. Pp. 80. (London: Adam Hilger, Ltd., 1939.) 7*s*. 6*d*. net.

MODERN spectrographs suitable for industrial work originated in Great Britain nearly thirty years ago, and their application to industry has been continuously increasing for three main reasons. First, for purely routine control, the spectrographic method is often much more rapid than a purely chemical one and, moreover, may require fewer workers. Secondly, chemical analysis may be less reliable when the estimation of mere traces of certain elements is involved. Finally, only small quantities of material are required for spectrographic analysis.

The monograph under consideration comprises twenty-eight articles describing the application of spectroscopic methods to a wide range of subjects, including analysis of alloys, detection of metallic contamination of beers, agricultural problems, archæology, and last, but by no means least, to forensic science. All the articles are brief.

The spectrograph, for example, has proved helpful in tracking down the causes of obscure diseases of crops and stock. Thus teart, to which cattle in certain areas are subject, is found to be associated with an increased molybdenum content in the herbage. In view of the minute traces of molybdenum involved, a long time would undoubtedly have elapsed before this discovery could have been made, had chemical methods alone been available.

The concluding article, which deals with forensic science, suggests numerous ways in which the spectroscope can assist in tracking the criminal. Thus counterfeit coins may be compared with dust from the suspect's pockets; a fragment of glass from the turn-up of a suspect's trousers may be compared with the glass of a window broken in a smash and grab raid.

The monograph may be recommended to all interested in the application of spectroscopy to almost every walk of life.

J. NEWTON FRIEND.

THE FACTORS OF THE MIND

The Factorial Analysis of Human Ability
By Prof. Godfrey H. Thomson. Pp. xv + 326. (London: University of London Press, Ltd., 1939.) 16*s*. net.

MOST psychologists have assumed that all mental activities are reducible to a small number of independent 'factors', such as intelligence, emotionality, verbal capacity, manual capacity, introversion or its opposite, and the like. Prof. Thomson's book is concerned, not so much with discovering what these factors may be, but rather with a critical examination of the mathematical procedure by which, it has been claimed, their existence may be established.

The older 'faculty school' simply postulated such elementary capacities as they were required; the newer school of statistical psychology supposes that they can be deduced mathematically by analysing correlations between test-performances or estimates of character. Various methods have been devised for this purpose—all loosely covered by the broad term 'factor analysis'. Of these the earliest was Prof. C. Spearman's well-known attempt to demonstrate that all mental processes involve a single intellectual factor, identifiable with 'general intelligence'. His formulæ assumed that two factors only were sufficient to account for every test performance. Later work in Great Britain, particularly in the field of educational testing, indicated that more specialized factors (verbal capacity, arithmetical capacity, etc.) appeared to enter into different tests, in addition to the 'specific factor' peculiar to each one and the 'general factor' common to all. The notion of multiple factors, as a substitute for that of dual factors, has since found strong support in America; and recent workers have endeavoured in various ways to generalize the simpler theorems of the two-factor hypothesis to meet these wider needs.

In the book under notice, Prof. Thomson brings together into a single clear and systematic exposition all the chief factorial methods that have hitherto been put forward. He explains their mathematical derivation in an elementary way for the student of psychology, and briefly compares their merits and their disadvantages. He also incorporates a summary of his own very valuable contributions, including more particularly a revised version of the sampling theory which he

had put forward as an alternative to the two-factor theory of Prof. Spearman. From the first page to the last the treatment is remarkably lucid, suggestive, and impartial.

Prof. Thomson claims that his book is written primarily for the reader "with little or no mathematical knowledge beyond what is ordinarily imparted in the secondary school". Nevertheless, even the professional psychologist and statistician will welcome the compendium of formulæ and proofs brought together in the mathematical appendix, and throughout the book will find new light continually shed on old problems. In common with most recent contributors to the subject, Prof. Thomson believes that these problems are best solved by matrix algebra; and, in their abstract form, the solutions reached are, as a matter of fact, often strikingly similar to results independently obtained by quantum physicists. But, as the present reviewer has more than once pointed out, although these methods were originally developed for the analysis of the results of psychological testing, they would be almost equally applicable to the solution of analogous problems in many other fields—in physiology, biology, sociology, medicine, economics, agriculture and, indeed, in almost any science where causal factors are numerous and inextricably interlinked. The book must at once take its place as one of the most important publications of the year in the field of education and psychology; at the same time it should be of great interest to all who are engaged on statistical research, no matter what their special sphere. C. B.

TABLES FOR STATISTICIANS

Statistical Tables for Biological Agricultural and Medical Research

By Prof. R. A. Fisher and F. Yates. Pp. viii+90. (London and Edinburgh: Oliver and Boyd, 1938.) 12*s*. 6*d*. net.

MODERN statistical analysis, particularly that relating to the production of adequate and exact tests of significance, owes much to the painstaking researches of R. A. Fisher, whose text-book, "Statistical Methods for Research Workers", has gone through a number of editions since it was first published in 1925. Not the least valuable feature of this work is the collection of tables, which have proved so indispensable to the statistical worker of to-day that they have been repeatedly referred to, and in certain cases reprinted, through the generosity of author and publisher. The desirability of having them separately published has been felt in many quarters, and in the volume now before us we have a work in which the tables of Fisher's book have been not only reprinted but also amplified, and many other tables have been added. While not a complete manual of statistical tables, available for all purposes (it is not, for example, very easy to fit a normal curve from the tables provided), the book is a very useful collection, and should be the indispensable companion of every statistician.

The first set of tables consists of those from Fisher's book, considerably extended (especially as to the z-table and its accompanying "variance ratio"), and with two new tables. The second set consists of tables of probits and angular transformations, found useful in medical research. We then come to a section of non-numerical tables, lists of Latin squares, and combinatorial solutions required for the design of balanced incomplete blocks—a set of tables which should be very useful to the agricultural experimenter. Following this are tables of a more miscellaneous character, including an interesting and useful new table of orthogonal polynomials, which should much simplify the calculations in problems of fitting curves. Finally, to complete the set, we have tables of logarithms, including natural logarithms up to 100, squares, square roots, etc., and tables of certain trigonometric functions. The last is a new table of random numbers.

As an example of mathematical table construction the work is excellent. The printing, spacing and presentation, and the large flat page, are according to the best canons. Where interpolation is necessary, the tables are adequate for the purpose, and the methods to be used are stated. In the case of standard tables, with mean differences, there is the interesting innovation of providing mean differences for half the interval only, thus teaching the user to subtract as well as add, and making for greater accuracy in the final result. The introduction, as is to be expected, has points of originality and interest, and is in itself a worthy piece of mathematical research. While some readers may be disappointed by not having standard uses of the standard tables illustrated, they will on the other hand welcome new statistical tests there described, together with suggested new uses of old tables, and the ways of using effectively the new tables. J. WISHART.

PERSPECTIVES IN EVOLUTION*

By PROF. J. RITCHIE
UNIVERSITY OF EDINBURGH

"ALL useless science is an empty boast," Shakespeare is alleged to have said, but he lived before that pernicious cleavage had been made between pure science and economic science, which suggests, as Hinton once said, that the latter is a gold-digger while the former excavates only knowledge. And while we are strongly in favour of those lines of scientific endeavour which make their first purpose an attack upon the evils that man and his possessions fall heir to in the course of Nature, and which aim at easing the human struggle for existence, there are questions of no immediate practical moment to which the inquiring spirit of humanity demands an answer. I do not think Shakespeare would have called these recurrent problems "useless science", for the mind of man requires satisfaction as well as his material need.

THE SECRET OF LIFE

Much that was mysterious about life has disappeared or is disappearing before the persistent inquiries of the physicist and chemist. Life processes of the physiological order are ruled and guided by the self-same laws which regulate action in the non-living world.

But it is just as obvious that none of these interpretations reaches the secret spring of life itself. The physical explanation of the architecture of animals must assume the power of the living thing to react and mould itself to the forces that play upon it. The Donnan equilibrium, which interprets a condition of thermodynamical balance, meets the case of a living cell only when the cell activity is at its lowest, and the more active, that is the more alive, a cell is, the less does the Donnan theory become applicable. Enzymes may be necessary for the complete activity of a cell, but, though it may hasten a chemical reaction, no catalyst can set a reaction in motion; in the case of the cell that appears to be the prerogative of 'life'.

Let us turn, then, from the minute analysis of the unit of life which in recent years has done so much to reduce the mystery of life, without, however, reaching the kernel of the mystery, to see what suggestion may arise from another point of view, a perspective of evolutionary processes.

The occurrence of certain organic aggregates on land and in the ocean, and the increase in orderly arrangement of matter revealed in the evolution of life from more simple to more complex, leads to the conclusion that in practice the second law of thermodynamics, so well established for physical happenings, cannot be satisfactorily applied to living processes; and that while no one would deny that living things in the long run and in a universal sense are subject to its demands, and indeed that in their workings they are probably controlled by it, nevertheless organisms *appear* to be able temporarily to hold up or withstand the physical course of degradation of matter, if they do not actually reverse it.

From this point of view, then, the secret of the living organism, that is its essential difference from non-living matter, is its power of trading with its environment in such a way that it can build up its body stores of high potential energy from materials of lower potential.

Phenomena of life elude treatment by the laws of thermodynamics, not necessarily because living matter does not obey these laws, but because the unknown conditioning of working organisms is too complex to yield to analysis applicable to inorganic states. Nor does it seem likely, since livingness exists within a very limited range of temperature and is readily extinguished by interferences, that it can ever be subjected to the sort of analysis which has led to the interpretation of the constitution of physical matter. It seems logical, therefore, to take as axiomatic the existence of life, not as a vital force which animates something different, namely matter, but as the activity of an atomic combination the very activity of which renders it unanalysable by the standard methods of the physicist and chemist. Thus, as one of the greatest of living physicists, Niels Bohr, has pointed out, the biologist would accept for the living world a position analogous to that accepted by the physicist for the non-living. "The existence of life must be considered as an elementary fact that cannot be explained, but must be taken as a starting-point in biology, as in a similar way the quantum of action, which appears as an irrational element from the point of view of mechanical physics, taken together with the existence of the elementary particles, forms the foundation of atomic physics."

The biologist, admitting 'life', may build up a whole body of biological theory, as distinctive and peculiarly his own, and as logical in the logic of probability which Professor Darwin advocates, as are the theories of the physicist or the chemist in their own limited fields.

* From the presidential address before Section D (Zoology) of the British Association, delivered at Dundee on August 31.

Lengthening of Life Perspective

There is another notable development of this century which must affect evolutionary thought, the expanding idea of the time during which the earth and life upon the earth have been in existence.

From the earlier discussions it would appear that a psychological element entered into the final estimates, as if the calculators drew back aghast at the possibility of the enormous age of the earth at which their estimates hinted. Thus almost all tended in their final summing towards the minimum of their scales, and little is heard of the other extreme—Lord Kelvin's independent maxima, reached by different methods, of 1,000, 400 and 500 million years, or Geikie's 400 million years—although these came much nearer to the modern estimate.

Now, a consensus of opinion admits credibility to estimates based upon the break-up of radioactive minerals in the rocks. We may say that life has existed upon the earth for perhaps 1,200 millions of years; and then to complete the picture that the birth of the earth and, as the new cosmology seems to indicate, perhaps also at the same time the stupendous birth of sun and stars, took place about 2,000 million years ago.

Stability of Organism and Slowness of Evolution

This amazing extension of the time concept of life emphasizes anew some of the striking features of evolution. We are accustomed to lay stress on the variation of living things, upon which evolution depends, but surely more remarkable is the stability of living organisms, which retain their own characters in spite of changes in the environment, and whose germ cells pass these characters unaltered through countless generations. The edible mussel (*Cardium edule*) has retained its specific characters for two million years or more; its genus, in a wide sense, lived 160 million years ago in the Trias. The Crinoid genus Antedon which flourishes in our own seas antedated that old bird Archæopteryx in the Jurassic Period, 140 million years ago. It is surprising enough to realize that genera of foraminifera, like Nodosaria (Silurian) and Saccammina (Ordovician), still abundant in our oceans, have retained their generic characters for about 300 million years. But they are relatively simple organisms; it is still more astonishing to think that contemporaneous with them or before them lived modern genera (again in the wide sense) of more highly organized brachipods, like Lingula (Ordovician) and Crania (Ordovician), and that these have experienced the geological upheavals and secular changes since Palæozoic times without turning a hair, or, in the revised version, without the shift of a gene upon a chromosome.

It is in agreement with that stability of organisms that we must conceive of evolution as a process of extreme slowness, as if living things are loth to change, and ultimately change only under the direct compulsion of circumstances. Of that slow progress in its minor phases the new chronology gives us a measure.

If this time-factor is a necessary element in the evolution of species in Nature, doubt is thrown upon the validity of arguments concerning evolution based upon laboratory experiments, in which intensification of means produces rapid change. There is no reason why the reaction of an organism under such exaggerated stimuli should be the same as that produced by minimal influences of the same nature over an exceedingly long time. Even in inorganic Nature the reaction of inanimate environment may differ according to the time element. The sensitive organism delicately adjusted to a particular environment is less likely than inorganic environment to give a 'natural' answer under concentrated compulsion.

Advent of Man and Evolution

The lengthening of the time perspective of life upon the earth adds new insignificance to the span of man's tenancy of the world and new impressiveness to the part he has played as an agent in evolutionary processes. Man of our own genus, beginning in the early Pleistocene Period, has probably less than a million years behind him, but the species of man now dominant in the world (*Homo sapiens*) appeared only at the close of the Würm Glacial stage, no longer than 25,000 to 40,000 years ago. Yet even this relatively short space of time exceeds man's span as an effective agent in world change, for in spite of the arts he developed in early post-glacial times he remained practically submerged in the fauna, having little more influence upon his environment than the beasts with which he shared it.

It was Neolithic man who set the ball a-rolling through his outstanding achievements in domesticating wild animals and in developing the cultivation of the soil and the growing of crops. For these achievements, apart from laying the foundation of a new era in the progress of civilization, started a series of changes which have profoundly influenced the distribution of life upon the earth. In one direction the safety of flocks and herds demanded the elimination of beasts and birds which threatened them, and in another the need of land for crops and pasturage played havoc with the wild environment and so with the fauna which it sustained and sheltered, although the crops themselves

encouraged the multiplication of certain elements in the fauna which became the pests of agriculture.

The Neolithic Age, which originated these changes, reached Western Europe only some 8,000 years B.C., though in the East and in the lands of old culture it began several thousands of years earlier. But Neolithic man, although he initiated the most far-reaching changes in plant and animal life, was himself, with his implements of wood and stone and limited powers of offence, ineffective in his interference. Even in a limited area like Scotland, few animals died out during his rule and it would be difficult to bring home to him responsibility for their disappearance. For the effective introduction of man as an agent of evolutionary change we must look to a time more recent. And that time is determined by his increasing efficiency as a cultivator and destroyer, and particularly by the need for food and fire demanded by an increasing population. These influences began to make their mark about the tenth century of our era, when several of the interesting members of the primeval fauna of Great Britain had disappeared or were on the verge of extinction, but in the centuries following the sixteenth they commenced a period of pressure, which, increasing in intensity, has transformed the faunas of civilized lands.

It is not an accident that the emergence of man as a major factor in the evolution of faunas coincided with the increased power of destruction presented to him by the invention of gunpowder and guns, and with that extraordinary increase in population which in the last three hundred years has multiplied, almost five times over, the numbers of mankind upon the earth. For this burst of population was itself the accompaniment of intensified agriculture and stock-rearing, of the spread of industries and development of commerce, all of which have had profound repercussions upon aboriginal faunas and floras.

While modern man has existed upon the earth for some 30,000 years, his part as a distinctive agent in the evolution of faunas is limited to a thousand years, and within that span his great transformations are practically confined to the last three hundred years. That is a period infinitesimally short compared with the ages during which the aboriginal faunas into which he was launched had been differentiating, redistributing and establishing themselves in a natural balance. What transformations has he wrought in so short a time?

I do not propose here to examine in detail the magnitude of this new world factor in the evolution of faunas and floras. That is best shown in a limited area which can be intensively studied, and I have elsewhere described with reasonable thoroughness the stages and sum-total of this process in Scotland, the recent geological history of which makes it particularly suited for such an analysis.

I may, however, indicate the depth of penetration of this new faunistic factor by pointing out how superficial is the view that regards man merely or mainly as a destroyer. He has indeed deliberately reduced numbers or extirpated animals for his own protection or for that of his flocks and crops, for food and other necessities, for sport, and to satisfy the whims of luxury; and without intention his cultivation of plains and marshes and destruction of primeval forest have destroyed feeding grounds and banished their former tenants. Yet his addition to numbers far outweighs his destruction. Intensive cultivation has added a stock of domestic animals far beyond the bearing capacity of wild country, besides increasing the numbers of wild creatures which also benefit from his crops. Deliberate protection of animals, for sport, for utility, for æsthetic reasons, and on account of popular superstition, has also multiplied numbers. Furthermore, apart from numerical changes within the aboriginal faunas, man has changed their qualitative composition by introducing foreign animals deliberately (here we must include domestic animals), and unintentionally through the ramifications of international commerce.

These are simple primary effects of man's interference; secondary and remote consequences are even more impressive in their ultimate issues. In general it may be said that, wherever civilization has made itself felt, three main faunal changes are noticeable: the largest animals tend to be reduced in numbers and eventually to disappear; smaller creatures, dependent upon cultivation and human habitations, multiply far beyond aboriginal numbers; and the deliberate or accidental spread of 'foreign' creatures is creating a degree of cosmopolitanism throughout the world's faunas.

How do these changes brought about by man stand, viewed in the perspective of the long evolution of faunas upon the earth? There are two types of change in progress in the natural assemblage of animals in any region. There is a constant ebb and flow within the fauna itself due to local and temporary influences, a swing of the pendulum about a mean, the 'balance of life' which is never quite struck. But there is also a faunal drift, revealed in the story of the rocks or in any long vista of faunal history, and this is due to great secular changes, to geological influences, to modifications of climate, to the insurgence of the forces of life.

Where man's interference is temporary and casual it may be compared to the internal faunal tide, which is of little moment in the long run;

but where his interference is persistent in any direction it must be reckoned as sharing with the great secular forces of Nature in propelling a fauna upon a path along which there is no return.

Such is the remarkable conclusion to which the long view of man's place as a natural agent brings us—that he has set in motion forces which, in our era and mainly in the last three hundred years, have wrought faunal changes which can be compared only with the great secular changes of world evolution. When the ridiculously short span of his interference is contrasted with the slowness of natural processes, the probability forces itself upon us that in a few more thousand years of man's inheritance of the earth the old order of Nature will be superseded in the faunas of the world by a new order of mankind.

Man in Evolutionary Perspective

Having thus assigned to man dominance among the forces which determine faunal assemblages, let me now endeavour to put him in his place in the long perspective of life and evolution.

Many have speculated upon the new view of man's future. To some it has seemed likely that future progress will be along the lines of individual development, that brains and mind will become more perfect in their working until man is master of all Nature. Others look to a future in which not the individual as a unit, but society as an integration of individuals will become more closely knit and more perfect in its functioning.

Still others see in the modern developments and threats of warfare a warning finger of the doom of civilization. I would remind these doubters that evolution as we know it is built upon destruction; that the development of the whole animal kingdom rests upon the destruction of green plants, which biologically are formed of the same stuff as we are, and that within the animal kingdom the flesh-eaters have risen upon the bodies of their fellow-creatures. The drama of wars amongst mankind and the imminence of war seizes the imagination, and history-books bias the mind by emphasizing wars and ignoring the quiet but effective work of millions of unknown citizens through the ages. But in our perspective of hundreds of millions of years these are the merest incidents and, war or no war, the quiet progress of evolution flows through life carrying the world of living things steadily but unobtrusively from one step to a higher.

In his short past man has been moving towards a higher intellectual, spiritual and moral standard, and the biological view would be that in the immediate future (geologically speaking) that movement will continue, and that for human beings this future lies in the development and perfection of social life and in the spreading of the social idea to include peoples and nations as well as individuals, with all the correlated advances that these imply.

That is the short view of man's future, but what of the long view of mankind upon the earth? I notice that Sir James Jeans contemplates, at any rate fancifully, the existence and progress of humanity until the shadow of the extinction of life upon the earth falls upon the world, many millions of years hence. Does our vista of life support such a view? We must admit that any view of science about the future of humanity can be only a short-range forecast; of the long-range forecast it can say nothing. The reason is that science knows only the past and the present, so that it can read into the future only the glorification or degradation of what has already been expressed in mankind, let us say better brains, better social organization, less self-seeking. Yet the unfathomable characteristic of life is that it is always throwing up something new; evolution proceeds not only by permutations and combinations of the old, but by the emergence of new lines of development. The physicist can foretell with accuracy the movements of the planets, the return of eclipses and comets, but who, knowing only fishes, could have foretold the amphibia which arose from them, or, knowing only the reptiles, could have foretold their descendants the birds and the mammals? When we leave details in the world of living things we can be wise only after the event; we cannot be wise before the event. Therefore the long future of evolution upon the earth is unknowable, so far as science is concerned.

Nevertheless, bearing that warning in mind, we may gain some hint from our perspective of life upon the earth.

We look upon man, and rightly so, as the crowning glory of evolution: stage by stage, we say, the evolution of the past has led up to him; we can imagine nothing higher, evolution appears to have reached its goal.

But step back some 180 million years in our time-scale to the Triassic period when the great dinosaurs dominated the earth and nothing higher than reptiles had been evolved. To themselves and to the creatures which shared the world with them, they must have seemed (if they had any self-consciousness), and indeed they were, the crowning glory of creation; stage by stage the evolution of the past had led up to them; nothing higher could be imagined, evolution appeared to have reached its goal. That could be said by their contemporaries of the highest creatures at every stage in the course of 1,200 million years of evolution, just as it is said of man to-day. A hundred million years have rolled past since the

time of the dinosaurs, and they and all their immediate kin have disappeared for ever, and new and unforeseen trends of life have blossomed, as they have done over and over again, and have carried the story of evolution on to the present, when man is the dominant and highest.

Looking back over that 1,200-million-year vista of the steady climb of life upon the path of evolution, it seems presumptuous for us to suppose that man, the latest newcomer, is the last word or the final crowning glory amongst many, and that with his coming the great steps in evolution have come to an end. Looking forward to the future of life upon the earth, it seems even more presumptuous for us to suppose that for the next 1,000 million years life, so surprisingly inventive in the past, should be tied for all time to come to trifling changes like increase of brain power or better social organization for mankind.

The truth is that we, bound by the past, can imagine nothing more, but if the long vista of evolution is any clue to the future, we cannot regard mankind, the crowning glory of the present, to be more than a stage in life's progress and a milestone upon the path of evolution towards a greater future. To think otherwise is to imagine that with the coming of man, so insignificant in time, the advance and inventiveness of evolution, steadily carried on through an unimaginable vista of years in which no trace of slackening can be perceived, has all but come to an end.

It may seem to you that our perspectives have carried us far afield into a future so remote that it is scarcely worthy of consideration. My excuse must be that we are so accustomed to think of man as the sole significant inhabitant of the world that it is worth while now and again to look upon him in his biological setting as but one, and yet so far the greatest, of the manifestations of life upon the earth.

THE FUTURE OF FLYING*

By Dr. H. E. Wimperis, C.B., C.B.E.

Lately Director of Scientific Research, Air Ministry

EVER since man inhabited the earth, he has lived not by his physical powers, which are slight, but by the exercise of his wits. Every new invention he has made has had its warlike use as well as its peaceful purpose, and each has challenged his wits to ensure that good rather than harm shall result from the new discovery. To bend the newest invention of all, the conquest of the air, to the service of mankind is now his great task. In it, success is essential lest we presently find that it is the air that has conquered mankind rather than mankind the air. Before we can regard the conquest of the air as achieved, we must control the warlike menace.

I believe that the scientific advances of the present time, and their probable development in the near future, will help us to solve, and not to aggravate, our central problem—the task Lawrence of Arabia spoke of as "the biggest thing to do in the world to-day"—to bend the newest invention of all, the conquest of the air, to the true service of mankind.

Mechanical flight was achieved when Wilbur Wright flew in December 1903 in that odd-looking machine now so proudly housed in the Science Museum at South Kensington. It certainly does look a queer machine to modern eyes. Although the engine weighed 180 lb., it gave but 12 h.p.! Of course it was natural that this, like all the other early aeroplanes, should be built with two pairs of wings. Engineers were well accustomed to carrying bending moments by a form of girder construction having an upper and a lower boom, and in the biplane form of construction the loads could be carried in this familiar way. Such early trials as were made of the monoplane type merely seemed to confirm the idea that a strong wing structure could not thus be found, and the biplane became the accepted type. Speeds in those days were low, and even long after the war of 1914–18 it was thought that the attainment of high speed would be mainly a matter of putting in more and more engine power. More and more power was accordingly put in. This led indeed to the achievement of higher speeds, but far-sighted designers saw that there was a limit to the extent of progress by this means. But, as a Spanish proverb has it: "When one door shuts another opens". The new door in this case proved to be the streamlining of the external form of the craft as a whole.

That the cleaning up of the aerodynamic structure could carry performance much further than had hitherto been realized, and do so without any increase of engine power, was first clearly

* From the presidential address to Section G (Engineering) of the British Association, delivered at Dundee on August 31.

pointed out, little more than ten years ago, by Prof. B. M. Jones of Cambridge.

FLYING TO-DAY

The consequence of these and other changes in design from the original Wright machine brought a steady growth in speed, which during the last score of years has increased by an average of well over 10 miles an hour in each year.

Speeds have grown because of the smoother shapes used in construction and through the greater engine powers provided. Can speeds continue to rise indefinitely? We may have gone almost as far as we can in using ship-shaped forms, though we still know very little about the possibility of ensuring an increase in the extent of the laminar flow of the air over the surface of wings or body: if this could be done the resistance would drop considerably. So far as prospective increases in engine power are concerned, there is little publicly revealed in these days, but one hears of testing plants being adapted to deal with engines of no less than 3,000 h.p. apiece. But even with these increases a definite speed limit is being approached —not one imposed by the laws of any State but by the laws of Nature. As I pointed out two years ago in a presidential address to the Royal Aeronautical Society, there is good reason to believe that, although speeds of 500 m.p.h. may be attained, it is unlikely that 600 m.p h. will be much if at all exceeded, for the latter figure is some 80 per cent of the speed of sound, and when the latter is approached the drag rises to a level far ahead of any prospective engine improvements. Although nothing in the physiology of man forbids even higher speeds, as witness the high orbital speed of the earth on which we all live with some measure of tempered comfort, there is soon imposed a physiological limit if high speed is combined with rapid manœuvre. If the latter is required, then the speed must be controlled to suit the conditions. Only the future can reveal how the balance between the two will be struck.

No simple summary can be given of what has been done as regards engine development, for, great as has been the change from the fifteen pounds per h.p. of the original Wright engine to the one pound, and less, of to-day, one remembers that in this one respect the engines of the last Schneider Trophy Race were as meritorious; where the latter were much below modern standards was in their lack of reliability when working at this power ratio. To-day's engines run without attention for hundreds of hours, a very different matter from endurance for a short race.

Even if engines of 3,000 h.p. may be said to be in sight, they are still some way from achievement. Progress depends not only on the skill of the engine designer and the metallurgist, but also on the ingenuity of the industrial chemist in producing his remarkable fuels—wonderful alike for their uniformity of quality and for their ability to resist detonation even when employed in engines of very high compression ratio.

Improvement in load-carrying capacity depends also on improvements in materials, though it is fair to designers to record the progress made in reducing the percentage which the structure forms of the total flying weight in modern aircraft. Nowadays as good a figure is shown for this in large flying-boats as in landplanes, a remarkable achievement. The flying-boat used to be thought of as slow and heavy, but to-day it holds its own, in efficiency, whether aerodynamic, structural, or economic, with any other mode of flight.

The flying-boats of to-day represent a great technical advance in quality over their predecessors of ten, or even five, years ago, but they have not yet shown any marked advance in size. The fine fleet of Empire flying-boats is made up of 20-ton units; the new Short 'Golden Hind' class for the Atlantic weigh 33 tons apiece; the Boeing 'Yankee Clipper' has a total weight of nearly 40 tons; but the 'Dornier Dox' which long preceded them ran to 50 tons laden. On the other hand, there has been a great gain in speed and in carrying capacity. The Boeing boat, for example, is reported to carry 10,000 lb. of load over and above its 4,000 gallons of fuel: as this amount of fuel will weigh 30,000 lb., this makes a total load of 40,000 lb., or almost exactly half of the total flying weight, the same as for the 'Golden Hind', and a truly remarkable percentage. The improved Empire flying-boats intended for the Atlantic crossing are planned to take-off at a flying weight of about 20 tons and to take 3 tons of additional fuel after they are air borne, by supply from a flying tanker on Sir Alan Cobham's scheme. This will increase the load on the wings from 30 lb. to 35 lb. per square foot, and may be regarded as a first step towards what could be done with wings specially designed and stressed for high loading. The 'Golden Hind' class is designed for a range of 3,400 miles without refuelling, and this with full load. Its early programme may include a survey flight along the route to Latin America.

It is naturally impossible in the course of this address to discuss all the many problems in the science of aeronautics which are being investigated at the present time. They are far too numerous and the time too short. But to some of them I must refer. One of great importance and quite fascinating interest is the investigation of the change in the air flow over a wing surface from the laminar to the turbulent state. It is known that if

the flow could be kept laminar, the drag would be vastly reduced, but it has yet to be discovered how to do this. A step in the right direction may lately have been made at the Langley Field Laboratories, for during Dr. Lewis's recent Wilbur Wright Lecture before the Royal Aeronautical Society mention was made of some wind tunnel tests in which a special form of aerofoil gave a drag coefficient figure of only about one-third of that usual. Further particulars will be awaited with interest. Many laboratories and experimental stations are studying this same problem, and, as not infrequently happens in such cases, success, once met with, itself creates a batch of new problems. For one thing it is clear that the presence of laminar flow can but be hindered by the use of the tractor type of airscrew now almost universal. It may be necessary to change to pusher designs, and as this will involve a marked rearward movement of the centre of gravity of the whole aircraft, all the stability factors will be gravely affected, to say nothing of the many engine problems also raised.

Other special problems relate to the possibility of having wing areas adjustable in flight by telescopic or other means, to the study of the very considerable increase in the control forces required of the pilot in large machines of high speed capacity, of the special problems raised by variable pitch airscrews, particularly in relation to the landing run, of the advantage at high air speeds of two-speed gear boxes, and of the special problems involved in pressure cabins.

The problem of the rotating wing is in a class by itself. Aircraft so fitted are quite unable to compete in speed with those with normal wings, but they easily beat the latter in take-off and landing. Many types are now in the field, the Cierva, the Hafner, the Kay and the Focke, to mention no others. The scientific problems are largely solved, as are the great mass of the mechanical ones. What is required is such a degree of user as will call for this form of aircraft to be constructed in numbers. When that happens, rotary wing aircraft will benefit in their design by that skilled attention from the production engineer which alone seems able to produce results that really look right.

The growth in recent years of the interest taken by the public in aviation, over land and over sea, is most striking. Partly, of course, it is due to the increase in the Air Arm and all that is thereby implied. But there is also a very rapidly growing use being made of the abundant facilities for air travel offered by the civil air transport services. The United States is often thought to lead the world in this respect—as it certainly does in the use of the automobile—but I believe that in proportion to the size of the population, and that is the true criterion, the total mileage flown annually is larger in Australia than it is in any other single country in the world; and there is good reason to expect that that pre-eminence is likely to continue.

THE FUTURE YEARS

Let us consider what lies ahead in the coming years in respect of speed, size and range. No doubt military craft will go as fast as they can. But since it seems that they cannot exceed 600 m.p.h. much if at all, there is little doubt that speeds between 500 and 600 m.p.h. will become usual. Not so, however, for the civil air services, where quiet, comfort and cost are all-important: here there is good economic reason for speeds to settle down in the 200–300 m.p.h. range. In both these classes we seem therefore to be approaching some degree of finality.

Altitude and range are alike in that so much depends on the discovery of new materials of construction and new ways of using them. Steady progress may be expected, though probably nothing sensational unless the use of reinforced plastics be so reckoned. For civil work the advantage of long-range flying depends on the ability to fly by night, and this is advancing rapidly. Radio services are improving and the vagaries of the ionosphere are becoming better understood. High altitude flying—whether in the stratosphere or just below it—requires the sealed cabin, and it will, I fancy, chiefly be sought by those whose first care is speed and whose lesser concern is cost.

When, however, we come to think of such other factors in the future of flying as the size of the craft, and the wing loading employed, we are concerned with quite other considerations. Size depends mainly on engine power, for there is a limit to the number of power units which can be conveniently looked after. Even if we have tractor and pusher airscrews in tandem (and tractor screws may well become unpopular where the highest aerodynamic efficiency is sought), six such pairs may be the practicable limit. This would give us twelve engines, which, at 3,000 h.p. apiece, makes the total power 36,000 h.p. At 15 lb. carried per h.p. available, this would give a total flying weight of 540,000 lb. or some 250 tons. Such a craft would naturally be a large boat, taking two hundred passengers or more; and that is the largest flying craft that can be said to be now in sight, although I ought perhaps to mention that in a lecture to the students of the Royal Aeronautical Society, who alone perhaps might be expected to live to see it, Dr. Roxbee-Cox was bold

enough to include an American forecast for a boat of 3,120 tons! But difficult as it may be to foretell accurately the future of the large flying-boat, there can be little doubt that we shall soon see such craft in active competition with their older rivals—which use the surface of the sea—for all rapid passenger transport on the important Atlantic routes.

The Air Arm

Among the world's many political preoccupations there is no more pressing or more intractable problem than that of curbing in some way the universal growth of armaments. It is true that, in so far as the product is entirely produced within the country of origin, the mere cost is of little moment. One makes armaments instead of making something else, and in the case of a people who loved above all having lots of lethal weapons, there would be nothing more to be said, though the taste might be thought odd!

It is not, however, solely a matter of finance, since normal peoples would much prefer the energy directed to armament production to be given to articles of service in civil life such as houses, pictures, sailing-boats, holiday camps and the like; and for the general body of such activity to be guided into channels which fit in with the quantity and quality of the labour available in the country. Moreover, just as a house containing a store of high explosives is not looked on as a happy abode, so there is always a fear that in highly armed international life a trigger in some remote spot may be pulled by accident, or by mischief, with irreparable harm to the whole world.

When some years ago an effort was made to come to an international understanding about air armaments, success was not attained. This was due, it is true, in some measure to the existence of strong professional interests and to the relative lack of attention to the needs of the ordinary man, but it was partly due to the inherent difficulty in the then state of the art of distinguishing between military and civil types. Even suppose, it was asked, that one could abolish all military aircraft, how would one deal with the civil types which could be so easily converted? In those days this was a germane question. But is it now? I think not, and for this reason.

The speeds of military aircraft are now in excess of 400 m.p.h. and will rise still higher. But civil aircraft rarely go faster than 250 m.p.h., and it is doubtful whether it is economically advantageous to have even so high a speed as that. This at once makes a great difference in the types. Again, the comfort and space needed for civil transport tends to produce a design of body which does not in the least resemble military requirements. In so far as the civil types in their really large sizes come more and more to take the flying-boat form, so are they the less like military types. Perhaps I should say here that I am leaving aside reconnaissance duties and troop-carrying, and thinking mainly of the aggressive type, the bomber.

Hence I submit that, as I suggested in a recent address at Chatham House, the position has been reached when, so far as technical considerations are concerned, an agreed limitation could be set on military production without the effort being nullified by the existence of civil types to which no such limitations applied. It must be remembered, however, that when a political man talks about 'parity in the air', he may not really understand what he is saying. What he probably means is equality in offensive force, for mere parity in numbers might be got by the absurd equation of putting 100 bombers plus 1,900 interceptor fighters as equal to 1,900 bombers plus 100 interceptors, because both sides add up to 2,000. It cannot worry any peace-loving country if one of its neighbours builds 1,000 or 10,000 interceptor fighters, any more than it would if that neighbour built immense numbers of anti-aircraft guns and searchlights. In fact, as a gain to the general strength of defence it would be rather comforting than otherwise.

In my view there will be no reason, once the international situation has cleared, why there should not be an agreed limitation in respect of numbers or tonnage of bombing aircraft—leaving the interceptor fighters entirely aside. It would be but cautious to agree on a limit to the speed of civil types, but as this would merely confirm what economic requirements would themselves suggest, it need be no hardship; excessively high speeds for civil types do not pay, are much more dangerous to passengers, are much more noisy to everyone, and need wasteful forms of air ports.

When this difficulty of our own age has been at last happily solved, we may be very content to leave our successors the even more threatening menace of dealing aright with the problem of atomic energy. This it is not necessary for me to describe. I will only say that, in a recent broadcast address, Prof. J. D. Cockcroft spoke of an atomic trigger action between the metal uranium and a single neutron which is reported to be capable of releasing a 100,000,000-fold increase in energy! Perhaps there are immense practical difficulties in doing this on a large scale; I earnestly hope there are! For ourselves we may well consider that in our own day we are quite sufficiently occupied with the thoughtful handling of our own special problem, how rightly to guide the future of flying.

NEWS AND VIEWS

The Universities and War

APART from the University of London, the rest of the universities of the British Isles are aiming at carrying on their work at their present posts, so far as is possible. A few departments and faculties of various universities have, we understand, made tentative arrangements to move to other quarters; but at present no steps have been taken. Dates for the beginning of the new term have been changed in certain cases. The University of Liverpool is to carry on at Liverpool, though instruction in certain faculties and departments will also be given at Harlech College on Cardigan Bay. Accommodation in certain colleges in Wales has also been acquired by that university, and will be used if necessary. So far as can be ascertained, the University of London is making the following changes: Administration—Royal Holloway College, Englefield Green, Surrey; Examinations—Courleigh, The Cleves, Reigate; University College—Aberystwyth (men), University of Sheffield (women); King's College—University of Bristol; Institute of Education—University College, Nottingham; Imperial College of Science and Technology—University of Edinburgh (Mining Department—Camborne, Cornwall); Queen Mary College—King's College, Cambridge; London School of Economics and Political Science—Peterhouse, Cambridge; School of Oriental Studies—Cambridge; Bedford College for Women—Girton College, Cambridge; Westfield College—St. Peter's Hall, Oxford; Goldsmiths' College—University College, Nottingham. The medical schools of the University are being distributed among several centres in Great Britain.

Blood-group Tests of Paternity

THE House of Lords Select Committee, to which the Bastardy (Blood Tests) Bill was referred after its second reading in February last (see NATURE, Feb. 18, p. 294), has now made its report. It will be remembered that this Bill, which was introduced in the House of Lords in December, 1938, by Lord Merthyr, sought to enable courts of summary jurisdiction to order blood-group tests to be made in bastardy cases. The chairman of the House of Lords Committee was Lord Strathcona and Mount Royal, and included among its members were Lord Dawson of Penn and the Bishop of Salisbury. The Committee gave it as its unanimous opinion that the qualities of blood underlying blood-grouping and the laws of inheritance governing the transmission of these qualities from parents to children are accepted by such a consensus of scientific opinion as to render it desirable in the interests of justice for this knowledge to be applicable to affiliation cases. After certain amendments, it recommended that the Bill be passed into law. It was stressed by the Committee that although the tests can exclude paternity in about one case out of three only, nevertheless the tests might prevent injustice. The Committee was also satisfied that the risk of error in making blood-tests has been reduced to negligible proportions; and it noted that the public is becoming ready to accept the positive verdict of science when its evidence declares against the implication of paternity to a given individual. It is indeed remarkable—and the Committee commented on the fact—how great was the preponderance of opinion among medical and legal witnesses in favour of the use of blood-tests as evidence in affiliation cases; while, of such criticisms as were offered, none disputed the validity of blood-tests as evidence.

Blood Groups and Paternity

A FURTHER refinement in the use of blood groups as a test of paternity was indicated by Dr. V. Friedenreich of Copenhagen at the seventh International Congress of Genetics which was held in Edinburgh immediately before the outbreak of war. Dr. Friedenreich, as reported in the *Lancet* of September 16, described the division of the *A* group into three varieties; A_1 is dominant to A_2 and A_3, and A_2 to A_3; A_3 is very rare. The distinction between A_1 and A_2 is already employed medico-legally on the Continent, thereby increasing the proportion of cases in which false accusations of paternity can be disproved. Reference to the important work of Dahr indicated a still further possibility of discrimination in that persons of constitution *AA* may soon be distinguished from those of constitution *AO*, a point of very considerable evidential value in the legal sense. From the anthropological point of view, the occurrence and distribution of groups *A* and *B* in both anthropoid apes and man constitutes a problem—so much so, indeed, that Dr. G. Montandon, of Paris, goes so far as to deny on this ground that it has any evidential value whatsoever as a criterion of race in man. Prof. Ruggles Gates, however, in a communication to the Congress at Edinburgh, argued that while gene *A* probably arose in the common ancestors of anthropoid apes and man, gene *B* in all probability arose much later by parallel mutation in both stocks.

Prehistoric Indian Village, New Mexico

AN expedition of the American Museum of Natural History of New York, under the leadership of Dr. Paul S. Martin, has been engaged in the examination and excavation of a number of Indian village sites in the mountainous region of western New Mexico. The villages are situated just off the route followed by the Spanish conquistador Coronado in his

unsuccessful search for the legendary wealth of the "Seven Cities of Cibola". According to a preliminary report from Dr. Martin, of which certain particulars have been issued through Science Service of Washington, D.C., there was little surface indication of the existence of any of the sites; and it was only the occurrence of scraps of Indian pottery, no larger than a thumb-nail, which directed the attention of the members of the expedition to one site which has been excavated. Even local pottery-hunters had failed to detect the existence of the villages. On this site the walls and floor of a large subterranean pit-house, presumably used by the inhabitants for ceremonial celebrations, has been uncovered. It measures 33 ft. in diameter, and is the largest of its kind hitherto excavated in this area. The objective of the expedition is the identification of sites belonging to the little-known Mogollon culture, one of the three cultural divisions into which American archæologists now classify the prehistoric cultures of the south-west, preceding and leading up to the great development of the Pueblos. Dr. Martin reports that he has found important evidence relating to the age and development of the Mogollon culture. He estimates that the site excavated was abandoned seven hundred years before Coronado's expedition of about the middle of the sixteenth century.

Archæological Reconnaissance in Roman Scotland

ALTHOUGH by this time the value of the aeroplane in archæological investigation stands in little need of further testimony, a record of recent discovery in Roman Scotland not only renews, as it were, the wonder at its achievement, but also affords striking evidence of how its use, and intensive examination of a terrain from the ground itself, combine with and supplement one another. The occasion of the demonstration was a survey from the air made in June last by Mr. O. G. S. Crawford, editor of *Antiquity* and archæological officer of the Ordnance Survey, to supplement previous work in preparation for archæological maps of Roman Scotland to be published by his department. The survey from the air was amply justified. It solved a number of knotty problems standing over from previous investigation, even after intensive field work, and in addition it added fresh data in the form of previously unrecorded native and Roman forts and fortlets, as well as a number of other discoveries of interest along the lines of the Roman roads in Annandale. Flying farther afield to the north, Mr. Crawford identified a Roman fort farther north of the Antonine Wall than any previously recorded, and on the return the modern method of reconnaissance was able to authenticate a site that has long been on record. Not only was it possible to make out the remains of rampart and road, both by observation and photograph, but also it can now be stated with complete certainty that it is a Roman fort, and further that a Roman road ran north-east from the gate in the rampart on that side of the fort—a fact of which certain implications for Roman dispositions in Scotland are made the subject of preliminary discussion in *Antiquity* of September by Mr. Crawford in his account of the reconnaissance.

Medicine in Ancient Ireland

IN a recent address before the Irish Free State Medical Union (*J. Irish Free State Med. Union*, 5, 22; 1939) Dr. T. P. C. Kirkpatrick stated that, like many other peoples, the Irish had a traditional god of healing, named Dianecht, who fitted the silver hand to King Nuada about the year 1272 B.C. According to the genealogies of MacFirbis, there were other physicians such as Eaba, the female physician, the second doctor who came to Erinn, and Fingen, who was physician to Conchobha MacNessa, whose hand he sutured with golden threads to match his hair. There is also some evidence of medical education in the country, as Josina, the ninth King of Scotland, came to Ireland about the second century B.C. to study medicine. There were, moreover, numerous schools in ancient Ireland, such as those at Clonard, Armagh, Clanmacnoise, Monasterboice and Portuma, in all of which medicine was probably taught. The Brehon or Ancient Laws of Ireland, which according to tradition were written down about the time of St. Patrick but had been in force for some time previously, show that the status of the leech or physician was well defined. In an ancient law tract an elaborate account is given of "Othrus" or "Sick Maintenance", which enacted that a person who had received physical injury from another should be given by his assailant not only the ordinary legal fine but also certain medical expenses. The position of the leech corresponded with that of the smiths, builders, goldworkers and Brehons, who were all high up in the social scale. The fees were fixed and depended on the social position of the patient and the nature of the disease. In addition to medical schools there were also hospitals, such as the "House of Sorrow" attached to the Red Branch at Emania where sick and wounded persons were treated, and the "Forus Tuatha" or territory house which is mentioned in the law tracts as a sort of hospital. Dr. Kirkpatrick concludes that medicine in ancient Ireland was probably as well developed as in any other contemporary country in western Europe.

Alcoholism and Mental Disease

IN his inaugural thesis (*Thèse de Paris*, No. 489; 1939), which is based on his experience at the Lesuellec Psychiatric Hospital, Dr. André Le Gall deals with the subject of alcoholism and mental disease in the Morbihan Department of Brittany. He points out that during the period 1910–37, since when the number admitted to the hospital each year has remained almost stationary, the admissions increased from 149 to 335, while the percentage of alcoholic patients rose from 7·52 in 1920 to 44·77 in 1937. The consequence has been that the total number of patients under treatment at the hospital rose from 778 in 1920 to 1,474 in 1938. There has also been a considerable increase in alcoholism among women, as is shown by the fact that while in 1911 they formed only 18·90 per cent of the total number of alcoholics, in 1937 this figure rose to 43·33

per cent. For several years the average age of the alcoholic patients has shown a tendency to fall, young persons of 20–30 being more numerous than formerly. Alcoholism was found to be as frequent among the married as among celibates, but was more liable to affect the rural than the urban population. In 1936, for example, only 15·73 per cent of the alcoholic admissions were manual labourers, as compared with farm labourers who formed 47·25 per cent of these admissions. The measures suggested by Dr. Le Gall for the control of alcoholism in Morbihan include suppression of the privileges allowed to home distillers, limitation of the number of public houses, the creation of dispensaries of mental hygiene, special homes for inebriates, especially for relapsing cases, the promotion of sport, and the encouragement of propaganda in favour of non-fermented apple juice, which has yielded excellent results in some countries, especially Switzerland.

Earthquake near the New Hebrides

THE United States Coast and Geodetic Survey, in co-operation with Science Service and the Jesuit Seismological Association, has determined the epicentre of the earthquake of August 12 to be provisionally latitude 13° S., longitude 169° E. The instrumental reports from Manila, Sitka, Weston, St. Louis, Fordham, Pasadena, Honolulu and Philadelphia also suggest that the depth of focus from which the shock originated was of the order of 150 km., thus making a deep focus earthquake. The epicentre is to the north of the New Hebrides and north-west of Fiji, being submarine in character. No damage has been reported, either directly due to the shock or to any abnormal sea waves. The region concerned is particularly liable to earthquakes and it is also noticeable that the frequency of earthquakes having deep focus is greater than normal in the whole of the region extending from Japan to the south of Fiji and including the area in question. A new Milne-Shaw seismograph and high-precision clock with seconds regulator have recently been sent on loan to Fiji by the British Association Seismological Committee at the suggestion of the Seismological Committee of the Australian and New Zealand Association for the Advancement of Science to replace the old Milne instrument there. This new seismograph will be particularly valuable for obtaining data for the study of deep focus earthquakes similar to the one mentioned above.

Mathematical Reviews

THE American Mathematical Society has founded a new international mathematical abstracting journal to be known as *Mathematical Reviews*. The first number is to appear late in 1939 or early in 1940; the material to be reviewed begins with the latter half of 1939. It is proposed to review all fields of pure mathematics and also those of applied mathematics and mathematical physics which are of pronounced interest to mathematicians. The new journal, which will be issued approximately once a month, will contain several thousand reviews annually and will run to approximately eight hundred large double-column pages. Prof. J. D. Tamarkin and Prof. Otto Neugebauer will be the first editors. The Carnegie Corporation has appropriated 60,000 dollars as a reserve for the new journal. The Rockefeller Foundation has made a gift of 12,000 dollars to cover some of the initial costs. Brown University is housing the project and aiding in the editorial work. The American Mathematical Society and the Mathematical Association of America are each beginning with a subsidy of 1,000 dollars for the first year. Annual subsidies are being sought from other organizations, and plans for the permanent financing of the project are being considered. On account of the generous subventions, the subscription price will be set drastically below actual cost.

PARTLY with the view of aiding indirectly in the support of this journal, the Rockefeller Foundation has made a handsome gift to Brown University for an experiment in the dissemination of mathematical publications through the distribution of microfilm. This money is to be used to augment the mathematical library at that University, a collection which is already internationally known as outstanding. Out-of-print journals will be put on film and made available to mathematicians; rare books of general use will be filmed; on request from a subscriber to the new journal, any article reviewed will be sent on film or as film-print. This service will be extended to all parts of the world at a price not exceeding cost. It should be of greatest value to mathematicians in the smaller universities and colleges, and should be a factor in encouraging young men to continue with their investigations.

Matter and Radiation

No. 704 of Hermann's "Actualités" series is by Prof. Louis de Broglie, editor of the volumes on theoretical physics, and is entitled "Le Principe de Correspondance et les Interactions entre la Matière et le Rayonnement". It extends to 170 pages (Paris: Hermann et Cie. 50 francs). The first 48 pages give an account of Maxwell's equations and their extension by Lorentz to cover electrons; the electromagnetic theory of dispersion; the theory of quanta; the correspondence principle introduced by Bohr in 1916; and Heisenberg's representation of the atom by a matrix of quantities all of which are directly observable. Then the principle of wave mechanics is introduced according to which the movement of material corpuscles is based on a certain equation of waves developed from the Hamiltonian function of classical mechanics. It is then shown that wave mechanics includes the correspondence principle and leads to a theory of the interaction of radiation and matter which, though not strictly logical, may be regarded as a first approximation. Later sections deal with the diffusion of light energy by matter, first without change of wave-length, then with such changes as are illustrated by the Compton and the Raman effects. The volume concludes with a study of photo-elec-

tricity in which the light quantum passes completely to matter, that is, the photon is annihilated. As one would expect from the author, wave mechanics is treated with great clearness and there is no attempt to represent the theory as having resolved all difficulties; on the contrary, at each partial success its incomplete nature is commented on and the requirements of a more complete solution are specified.

Egg Storage

A DESCRIPTION is given in the *Electrical Review* of September 15 of the Chelmsford Egg Supply Co. (1934). This company utilizes a process for the preservation of eggs which, it is claimed, keeps them fresh indefinitely. It is said that, if eggs are frozen below 28° F. they crack, so that storage by freezing is impracticable. Storage in gas is better, but it takes time for the gas to percolate through the shell. The company has, however, overcome this difficulty. Every egg has a small air space at the top. This increases as the egg ages. By means of a pump the air is extracted and replaced by carbon dioxide and nitrogen under a pressure of 250 mm., this pressure being maintained all the time the eggs are in storage. The eggs are stored in large cylinders each holding 234,000 eggs and are kept at a temperature of 30° F. Each refrigerating unit is driven by a 6 h.p. motor, and in addition, two extra motors are employed, 5 h.p. and 2·75 h.p. respectively, for circulating the water and ammonia. The gas-tight cylinders in which the eggs are stored look like large boilers. An additional chamber held at a much lower temperature is used for freezing liquid eggs, that is, those which have been accidently cracked, and are sold to local bakeries. The factory is also a national mark packing station capable of dealing with a million and a half eggs a week. The electricity taken per annum from the public supply is nearly 60,000 units. As this load is very nearly constant, and is heaviest during the summer months, the load factor is excellent and an attractive tariff is available. The seasonal difference in the price of eggs practically makes up for the cost of storage.

Extensions of Carrier Telephone Systems

IN the quarterly edition (No. 17) of *Nippon Electrical Engineering*, published in English by the Institute of Electrical Communication Engineers of Japan, there is an important paper on carrier telephone systems which make use of lighting and power distribution lines. It is written by N. Shinohara, Y. Hirano and M. Yoshioka, and contains many useful experimental and theoretical results. They point out that the economies effected by using existing power and lighting circuits as part of the carrier system make it possible to extend communication to out-of-the-way districts, as, for example, farming districts, fishing villages, lighthouses, etc. This will make possible the rapid cultural development of these places. They consider first of all the use of high-tension distribution lines as part of the carrier frequency transmission circuit. In the past this has been done by two systems; the first is called the metallic circuit system and the second the ground return circuit system. Although the first system excels the latter so far as low attenuation and noise are concerned, the second is the system which is more commonly employed owing to its greater economy and trustworthiness. The authors state that in utilizing the high-tension distribution line it is best to employ the ground return circuit system. The most commonly employed types of high-tension systems are the single-phase two-wire type and the three-phase three-wire type. The height of the wires above the ground is not uniform, but, where the line is even, the average height is about seven metres. By considering a single copper wire 5 mm. in diameter at a height of 7 metres above the ground and at a temperature of 20° C. and a frequency of 50 kc., they compute that the speed of the carrier waves is nearly equal to the speed of light and that the attenuation constant is very small. They conclude by describing a method of designing a circuit by a new telephone system which they state will be the most suitable for a rural district. They show how much more economical the new system would be than the one at present in use.

Oceanographical Results from Central America

IN July and August 1938, the President of the United States, the Honorable Franklin D. Roosevelt, undertook an inspection cruise and fishing expedition from San Diego, California, to Pensacola, Florida, by way of the Panama Canal, aboard the U.S.S. *Houston*. Between July 16 and August 9 some 5,888 miles were covered and fourteen different collecting stops were made, distributed among the possessions of five different nations: Mexico (Lower California and Socorro Island), France (Clipperton Island), Ecuador (the Galapagos Islands), Costa Rica (Cocos Island), and Colombia (Old Providence Island in the Caribbean). Dr. Waldo L. Schmitt of the United States National Museum accompanied the expedition as a naturalist. The results are published in a series of papers of which four are before us: "Decapod and Other Crustacea" (with Introduction and Data) (Smithsonian Miscellaneous Collections, **98**, No. 6, Pub. 3531) by Waldo L. Schmitt; "Molluscs" (Pub. 3535) by Paul Bartsch and Harald Alfred Rehder; "A New Holothurian of the Genus Thyone" (Pub. 3537) by Elisabeth Deichmann; and "Two New Gobioid Fishes" by Isaac Ginsburg (Pub. 3539), May–June 1939. A number of new species of Mollusca are described, and lists of species given from the various collecting grounds.

Grass Drying

A REPORT on fodder conservation with special reference to grass drying by E. J. Roberts has been published by the Agricultural Research Council (H.M. Stationery Office. 2*s*.). This is the third report on the subject, and embodies the results of the most recent experiments carried out with the co-operation of agricultural organizers, colleges and experimental farms in Great Britain. A detailed account

of grass-drying machinery and equipment is given, and comparison made with the various processes of artificial drying in other countries. There seems to be little doubt that the conservation of young grass is sound in principle, as it is then at its maximum nutritive value, and feeding trials show that it can largely replace concentrates. The question of the profitableness of grass-drying, however, cannot be answered so simply, as it depends both on the quality of the product and also on other matters such as the market value of the concentrates which it is to substitute, and whether the grass would have been utilized in some other manner or wasted through occurring at a time of surplus growth. The indirect advantages of the process, such as improvement of the sward, control of thistle, etc., must not be overlooked, nor the fact that the lower grades of dried grass are of higher value than the best hay. Profit-making, however, in this as in many farming enterprises, depends to a very large extent on the skill of the individual.

Agricultural Libraries

THE International Institute of Agriculture in Rome has just published a useful book of reference entitled "International Directory of Agricultural Libraries" (25 lira). The information consists of a list of all general agricultural libraries of more than two thousand volumes, libraries specialized in particular subjects, agricultural collections in general libraries, and centres of agricultural documentation. So far as possible, the history and size of the library and the subjects represented therein, the cataloguing and classification systems employed and regulations for the use of the library are stated. Relations with other libraries (exchange of publications, etc.), a bibliography of writings on the library and any publications edited by it are also mentioned. 1,200 libraries arranged according to country are described, and the text is written in both English and French.

Theodor Langhans (1839-1915)

THEODOR LANGHANS, an eminent German pathologist, who with the physician Sahli and the surgeon Kocher formed a triumvirate which made the Berne medical school famous, was born at Usingen, Nassau, on September 28, 1839. He received his medical education at Heidelberg; Göttingen, where he was a pupil of the celebrated anatomist Henle; Berlin, where he studied under Virchow, Trauber and Frerichs; and Würzburg, where he qualified in 1864 with a thesis on the structure of tendons and served as assistant to von Recklinghausen until 1867. He then went to Marburg, where he collaborated with Lieberkühn and Wagner in anatomical research. In 1868 he described the giant cells in tubercle to which his name has been given, and it was during his stay in Marburg that he carried out some important investigations on the absorption of extravasations and the formation of pigment. In 1872 he was appointed professor of morbid anatomy at Giessen, but in the same year succeeded Klebs in the corresponding chair at Berne, where he did valuable work on the morbid histology of the female breast, the histology of the placenta, the distribution of glycogen in normal and diseased organs, and described the cellular layer of the chorionic epithelium to which his name has been given. He also collaborated with Kocher in a study of diseases of the testicle. His later years were mainly devoted to researches on the morbid anatomy of goitre and cretinism. He retired from his chair two years before death, which took place on October 22, 1915.

Announcements

WE have been asked to state that the Geological Society of London is carrying on as usual at Burlington House. An announcement relating to meetings will be made in due course.

THE annual exhibition of the Royal Photographic Society is being held at the Society's House, 16 Prince's Gate, South Kensington. The exhibition is open from 10 a.m. until 5 p.m. daily (Sundays excepted) until October 7.

MR. JOHN RYMILL, the arctic and antarctic explorer, has been awarded the David Livingstone Centenary Gold Medal of the American Geographical Society in recognition of his leadership of the Graham Land Expedition. Mr. Rymill, who is an Australian, was a member of the British Arctic Air Route Expedition to Greenland in 1930–31, and took over the leadership when Mr. H. G. Watkins was lost. He led the Graham Land Expedition to the Antarctic in 1934.

THE Council of the Institution of Naval Architects has awarded the Martell scholarship in naval architecture (1939) to Mr. Norman W. Honey, of H.M. Dockyard, Sheerness; the scholarship is of the value of £130 per annum, and will be held at the Royal Naval College, Greenwich. The Earl of Durham Prize has been awarded to Mr. Peter E. Bish, of H.M. Dockyard, Devonport.

WE have received from the British Drug Houses, Ltd. (Graham Street, London, W.1.) the new catalogue of B.D.H. laboratory chemicals and testing outfits, which comprises nearly six thousand separate items and is provided with a general index. Section I has been enlarged by more than five hundred new items, mostly organic chemicals, and Section 2 contains an increased number of reagents and solutions for analytical and clinical purposes, and there is a new section of culture media. The products listed are normally held in stock for immediate delivery.

DR. ALBERT B. SABIN of the Rockefeller Institute of Medical Research has received the Theobald Smith award of 1,000 dollars from the American Association for the Advancement of Science in recognition of his rapid method of typing in pneumonia and for a quick bedside test of a patient's probable resistance to the disease.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. They cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 555.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Deuteron Bombardment of Silver

WE have bombarded pure silver with a few microampere-hours of 9 Mv. deuterons from the Cavendish cyclotron and have used a Geiger counter for investigating the radioactive radiations. The activities observed are listed below in order of prominence.

(1) A negative electron activity of 2·4 min. is found by analysis of the composite decay curve given by irradiated silver foil, the corresponding intensity for a control sample measuring only the background neutron effect being negligibly small. This activity is to be ascribed to ^{108}Ag formed by the reaction: ^{107}Ag (d,p) ^{108}Ag.

(2) Chemical separation into silver and cadmium fractions has been performed, and the latter portion has been found to contain a 6·8 hour body emitting a soft negative electron radiation (absorption limit 15 mgm. per sq. cm. of aluminium), X-rays and a very weak γ-radiation. A body with corresponding properties has been found as a product of proton capture in silver[1], and arguments have been adduced suggesting that the activity is due either to a metastable excited state of one of the isotopes, ^{106}Cd or ^{110}Cd, electrons and cadmium X-rays resulting from an efficient internal conversion of the de-excitation γ-rays, or to *K*-electron capture in an unstable isotope ^{107}Cd or ^{108}Cd, giving rise to silver X-rays together with photo-electrons. Favouring the validity of the former interpretation in our case are the apparent entire absence of the positron emission which would probably accompany *K*-capture, and also a significantly closer correspondence of the X-ray absorption coefficient in aluminium to the value for cadmium *K*-radiation than to that for the silver line. The appropriate reaction is: ^{107}Ag (d,n) ^{108*}Cd, or ^{109}Ag (d,n) ^{110*}Cd.

(3) The silver fraction contains a 26-min. body emitting positrons with an absorption limit corresponding to 1·8 Mv. This body thus has properties similar to those attributed to ^{108}Ag[2]; we are, however, unable to find any trace of the 8-day period belonging to the other isomer of ^{108}Ag, and, in any event, the mechanism of the formation is obscure. A control sample given the same chemical treatment as the positive sample shows the background neutron effect to be negligible.

(4) The silver portion gives also a negative electron activity which decays with a half-life of at least several weeks.

(5) Short-lived activity in the silver foil has been sought by beginning measurements within a quarter-minute of a short bombardment, but no half-life less than the 2·4 min. can be detected.

A comprehensive account of this and cognate work will be published elsewhere.

Cavendish Laboratory, Cambridge. R. S. KRISHNAN. D. H. T. GANT.

[1] Delsasso, Ridenour, Sherr and White, *Phys. Rev.*, **55**, 113 (1939).
[2] Pool, Cork and Thornton, *Phys. Rev.*, **52**, 380 (1937). Pool, *Phys. Rev.*, **53**, 116 (1938). Pool and Campbell, *Phys. Rev.*, **53**, 272 (1938). Feather and Dunworth, *Proc. Roy. Soc.*, A, **163**, 566 (1938).

THROUGH the kindness of Messrs. Krishnan and Gant, I have been able to examine the radiations from a silver foil of 20 mgm./cm.^{2} bombarded with 9 Mv. deuterons, using the method of critical absorption previously adopted in the case of the fission products of uranium[1]. For the quantum radiations from the 6·8-hour body, a palladium foil of 24 mgm./cm.^{2} was considerably more transparent than a foil of molybdenum of only 14 mgm./cm.^{2}. This is in agreement with the findings reported above, although it does not allow a decision to be made as to whether the *K*-radiations of silver or cadmium are involved (it is hoped, later, to use an absorber containing ruthenium in order to examine this point more closely).

Concerning the long-period activity (4, above), the method of critical absorption likewise indicates an intense quantum radiation much more strongly absorbed by molybdenum than by palladium, and a harder γ-radiation is also present. The negative electrons of the long-period activity have been examined in a special low-absorption counter arrangement, and an absorption limit of about 12 mgm./cm.^{2} has been found for them.

It will obviously be interesting to examine all these radiations in more detail to see if any reason can be found why they are so closely similar to those emitted by the 6·8-hour cadmium isotope.

N. FEATHER.

Cavendish Laboratory, Cambridge. August 25.

[1] Feather and Bretscher, NATURE, **143**, 516 (1939).

Fission of Thorium by Neutrons

SINCE March 1938, we have been engaged in the study of artificial radioactivity induced in thorium by fast neutrons. We have already reported[1] the production of uranium Y, which was obtained in the course of this investigation.

At that time we had examined the barium and lanthanum fractions from activated thorium and obtained nearly all the periods which Meitner, Strassmann and Hahn[2] found in their study of the artificial radioactivity of thorium, and which Hahn and Strassmann[3] and other authors later identified with those for fission products of uranium and thorium, although our agreements were not exact in some cases and some other periods were obtained in our experiments.

We did not, however, follow closely these lines of investigation, since our attention was directed to a radioactive substance, which was precipitated with bismuth and lead as carriers from hydrochloric acid solution by hydrogen sulphide. We spent much time on the chemical identification of this substance. Its chemical properties were not easy to ascertain, but it was still more difficult to understand the nuclear reactions concerned. Chemical properties suggested that either 'transuranic' or elements of lower atomic

number than bismuth were involved, but both these alternatives were difficult to accept at that time. Then, however, came Hahn and Strassmann's discovery of fission processes, and the problem became easier, at least in principle.

From this point of view we have been working on the chemical identification of elements for several months, but have not come yet to final conclusions. In the meantime, results on similar work were published by Bretscher and Cook[4] and by Meitner[5], but exact identification of elements was not given. Although our experiments are still in a very preliminary stage, we should like to give here the results so far obtained, since we are obliged to interrupt our work for some time.

Thorium nitrate, carefully freed from mesothorium as well as from other disintegration products except radiothorium, was exposed to fast neutrons which were produced by bombarding lithium with 3 Mv. deuterons of several microamperes from our cyclotron. The exposure ranged from one to five hours, after which the sample was subjected to chemical separations. Examination of radioactivity showed the production of the following active substances: Bi, Hg, Sb, Sn and Ag. Besides these elements, the following fractions were found to be radioactive: alkali fraction, halogen fraction, Mo-fraction, Se + Au-fraction, Cu + Cd-fraction. Identification of elements in these fractions requires further investigation.

We tested for radioactive lead and arsenic and proved their definite absence. Our chemical separations, however, took at least two or three hours and all radioactivities of short periods must have escaped our detection.

We tried similar experiments also with uranium, and so far have obtained the following radioactive precipitates: Bi, Hg, Ag, Sb + Sn, and Cu + Cd-fraction.

More thorough identification of radioactive elements both from thorium and uranium, and determination of their periods will be made in the future. Chemical procedures and details of the experiments will be given elsewhere.

We should like to acknowledge the assistance given by Messrs. N. Saito and N. Matuura in connexion with the chemical separations.

Y. NISHINA.
T. YASAKI.
H. EZOE.
Nuclear Research Laboratory,
Institute of Physical and
Chemical Research,
Tokyo.

K. KIMURA.
M. IKAWA.
Chemical Institute,
Faculty of Science,
Imperial University of Tokyo.
July 29.

[1] Nishina, Y., Yasaki, T., Kimura, K., and Ikawa, M., NATURE, **142**, 874 (1938).
[2] Meitner, L., Strassmann, F., and Hahn, O., *Z. Phys.*, **109**, 538 (1938).
[3] Hahn, O., and Strassmann, F., *Naturwiss.*, **26**, 756 (1938); **27**, 11 (1939); **27**, 89 (1939).
[4] Bretscher, E., and Cook, L. G., NATURE, **143**, 559 (1939).
[5] Meitner, L., NATURE, **143**, 637 (1939).

The Meson and Cosmology

THE mean life τ_0 ($\tau_0 \sim 2{\cdot}5 \times 10^{-6}$ sec.) of a meson at rest gives us a new fundamental constant of the dimension of time which lies intermediate between the 'atomic constant' τ_a (say, $\tau_a = \frac{R_0}{c} \sim 5{\cdot}5 \times 10^{-24}$ sec.) and the 'cosmological constant' t_0 ($t_0 \sim 2 \times 10^9$ years). R_0 denotes the 'classical radius' of the meson, $R_0 = \frac{e^2}{\mu c^2}$, where the symbols have their usual meaning. We shall take $\mu = 170\,m$, where m is the mass of an electron. We can construct from these basic time units (τ_a, τ_0, t_0) three dimensionless 'large numbers',

$$\frac{t_0}{\tau_a} \sim 1{\cdot}1 \times 10^{42}, \frac{t_0}{\tau_0} \sim 2{\cdot}5 \times 10^{22}, \frac{\tau_0}{\tau_a} \sim 4{\cdot}6 \times 10^{19},$$

and if, following Dirac and others, we make the hypothesis that 'large numbers' are interrelated, we have

$$\frac{t_0}{\tau_0} = \frac{\tau_0}{\tau_a} = \left(\frac{t_0}{\tau_a}\right)^{1/2}, \text{ or } \tau_0 = (\tau_a \cdot t_0)^{1/2}. \quad (1)$$

In comparing such large numbers any differences by factors of about 10^2 are to be ignored, as these could be easily taken account of by introducing the dimensionless numbers such as the fine-structure constant $\hbar c/e^2$, μ/m and H/m, H being the mass of a proton. Further, on this hypothesis we can connect the above large numbers with the (familiar) large number $e^2/G\mu^2 \sim 1{\cdot}4 \times 10^{39}$ formed from the gravitational constant G and the atomic constants e, μ. We have:

$$\frac{t_0}{\tau_a} = \frac{e^2}{G\mu^2}, \quad (2)$$

$$\frac{\tau_0}{\tau_a} = \left(\frac{e^2}{G\mu^2}\right)^{1/2}, \quad (3a)$$

$$\frac{t_0}{\tau_a} = \left(\frac{e^2}{G\mu^2}\right)^{1/2}. \quad (3b)$$

Equation (3*a*) in the form

$$L_0 \equiv c\tau_0 = R_0 \left(\frac{e^2}{G\mu^2}\right)^{1/2} \quad (4)$$

has already been given by Blackett[1].

It is of interest to note, as equation (1) shows, that in a system of measurement in which the atomic units remain constant the mean life of the meson is proportional to the square root of the epoch t_0, and as the mean life of the meson is intimately connected with β-decay, the mean life of a radioactive substance (β-activity) would vary as $t_0^{1/2}$.

D. S. KOTHARI.
Department of Physics,
University of Delhi.
July 28.

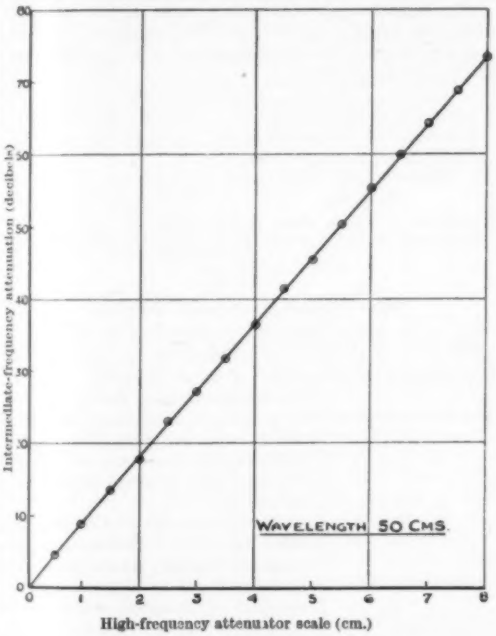
[1] NATURE, **144**, 30 (1939). This has suggested the present communication. It may be noted that if in (4) μ be replaced by the electron mass, L_0 becomes the maximum radius possible for a body composed of *degenerate* matter.

The Diode as a Frequency-Changer for Measurements at Ultra-High Frequencies

THE increasing use of ultra-short wave radio communication has created a need for the measurement of oscillating electric currents, potential differences, and field strengths, at very high frequencies, up to at least 300 megacycles per second. The difficulty of measuring these quantities can be greatly reduced by converting the original frequency to a much lower 'intermediate' frequency by the well-known heterodyne process, provided that the law is known which connects the amplitudes of oscillation at the two frequencies. Theory suggests that the diode frequency-changing circuit as described,

for example, by Strutt[1], possesses a linear conversion law if it is used with a heterodyning oscillation of sufficiently large amplitude. The linearity of this law has now been demonstrated by experiments carried out in the Radio Department of the National Physical Laboratory at frequencies between 4 and 600 megacycles per second for amplitudes between about 10 and 30,000 microvolts.

A variable high-frequency attenuator was constructed on the principle of the 'piston' attenuators described by Harnett and Case[2] and by George[3]. It depends on the space rate of decay of an oscillating electromagnetic field inside a conducting tube. Maxwell's theory, as developed by Rayleigh[4] and others, indicates that under the conditions of these experiments the amplitude decreases exponentially with distance along the tube, with a decay constant sensibly independent of frequency. This attenuator



was used in conjunction with a frequency-changer containing a commercial diode of ultra-short wave type, together with an intermediate-frequency amplifier (1·2 mc./s.) fitted with an attenuator and an output measuring instrument[5]. The intermediate-frequency attenuator was calibrated against a standard capacitance voltage-divider constructed in the laboratory. A high-frequency signal was applied to this system and the attenuations at the high frequency and at the intermediate frequency were adjusted simultaneously in opposite senses so that a constant reading was obtained on the output instrument. Measurements were made using oscillations of various frequencies and amplitudes within the limits mentioned above. The results were expressed graphically for each frequency by plotting scale readings of the high-frequency attenuator in centimetres of tube length against the corresponding scale readings of the intermediate-frequency attenuator in decibels. The graph, which is reproduced, was obtained at 600 megacycles per second and is typical.

The points lie closely about a straight line in each case, and the slope is independent of frequency. This would occur in the improbable circumstance that any departure from exponential attenuation should be exactly complementary at each frequency to the deviation from linearity of the frequency-changer law, but otherwise the result establishes the calibration of the high-frequency attenuator and its independence of frequency, and the linearity of the relationship between the amplitudes of the high-frequency and intermediate-frequency oscillations.

It is possible, as a result of these experiments, to compare with confidence the amplitudes of high-frequency oscillations by making observations at intermediate frequency after frequency-conversion in the manner previously described.

The above work was carried out as part of the programme of the Radio Research Board, and this letter is published by permission of the Department of Scientific and Industrial Research.

G. F. GAINSBOROUGH.

Radio Department,
National Physical Laboratory,
Teddington,
Middlesex.
July 9.

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Study of Diffusion Processes by Electrolysis with Micro-electrodes

THE diffusion of an electro-oxidizable or -reducible substance in solution can be studied by measuring the current obtained using suitable electrodes in an electrolysis cell under such conditions that the amount of electro-oxidizable or reducible material reaching one of the electrodes is determined only by the rate of diffusion of the material to the electrode. The concentration of the diffusing material at the electrode is maintained at a value practically equal to zero by applying a potential to the electrode such that the diffusing material is immediately oxidized or reduced upon reaching the electrode surface.

The theory of the diffusion process in the vicinity of an electrode depends upon the geometrical arrangement of the electrode and solution in contact with it. Two extreme geometric cases are represented by a flat electrode, to which diffusion can occur from only one direction (linear diffusion), and a spherical electrode, to which diffusion can occur from all directions (spherically symmetrical diffusion).

In the case of linear diffusion it can be derived[1,2] that

$$i = -A\sqrt{\frac{D}{\pi t}}\, nFC, \qquad (1)$$

in which i is the current at the time t, A is the area of the electrode, nF is the number of coulombs per mole of reacting substance, C is the concentration, and D the diffusion coefficient of the diffusing material. For spherical diffusion, the current-time equation is[2]

$$i = -4\pi RnFDC - A\sqrt{\frac{D}{\pi t}}\, nFC \qquad (2)$$

in which R is the radius of the spherical electrode.

In testing both equations, we have studied current-time curves of different substances at potentials

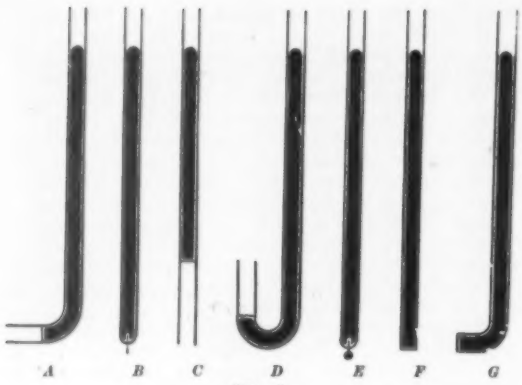

Fig. 1.

VARIOUS SHAPES OF PLATINUM ELECTRODES.

corresponding to the middle of the so-called diffusion current regions. Various electrodes of shapes shown in Fig. 1 were used. Current-time curves obtained in the electrolysis of 0·001 *M* potassium ferrocyanide in 0·1 *N* potassium chloride at 25° C. ± 0·02° are given in Fig. 2. A large 0·1 *N* silver - silver chloride served as a reference electrode. In all these experiments the potential of the platinum electrodes was 0·7 volt as referred to the silver - silver chloride electrode.

From the results presented in Fig. 2 and subsequent experiments to be reported elsewhere in detail, the following statements can be made:

(1) Theoretical current-time curves in the case of linear diffusion of potassium ferrocyanide were obtained only when using electrode *C*. In the cases of the electro-oxidation of ferrocyanide ions and of electro-reduction of silver ions at electrode *C*, where the linear diffusion was such as to produce a density gradient in the downward direction, the quantity $i\sqrt{t}$ (see equation 1) was found to be constant to ± 0·5 per cent over a period of twenty minutes. When the density gradient was in the upward direction (electrode *D*) abnormally large currents were obtained which did not give a smooth current-time curve. In the latter case, convection currents due to slight density gradients cause a greater supply of diffusing material to reach the electrode than by diffusion alone. This is the reason that in the electro-reduction of potassium ferricyanide in 0·1 *N* potassium chloride in air-free solution, theoretical current-time curves were obtained with electrode *D* but not with electrode *C*.

(2) Theoretical conditions were never attained with spherically symmetrical diffusion, due to localized convection currents as a result of density gradients in aqueous solution.

H. A. LAITINEN.
I. M. KOLTHOFF.

School of Chemistry,
Institute of Technology,
University of Minnesota,
Minneapolis, Minn.
July 20.

[1] Cottrell, F. G., *Z. phys. Chem.*, **42**, 385 (1902).
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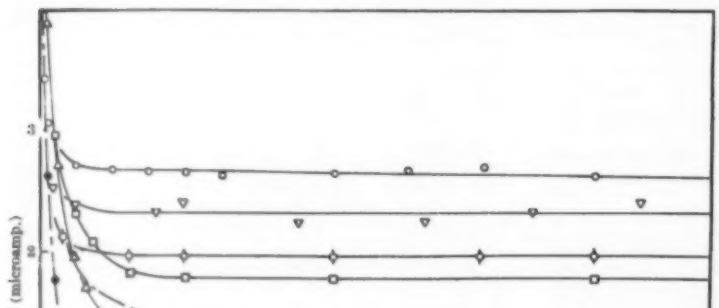

Fig. 2.

CURRENT-TIME CURVES FOR ELECTROLYSIS OF 0·001 *M*.$K_4Fe(CN)_6$ in 0·1 *N*.KCl with VARIOUS SHAPES OF PLATINUM MICRO-ELECTRODES.

● Electrode C; △ Electrode A; □ Electrode F;
ϕ Electrode B; ▽ Electrode E; ○ Electrode G.

Dashed curves: theoretical curves for (I) linear diffusion; (II) spherically symmetrical diffusion.

Solar Variation and the Weather

IN NATURE of April 29, p. 705, Dr. C. G. Abbot refers to the probability of weather periodicities in 274 months and factors of that interval. In this connexion it may be of interest to point out that there seems to be a periodic variation in the height of the barometer in Great Britain with a mean interval of 27·31 days.

Out of several stations examined, Greenwich had the longest series of records, and an analysis of these back to 1847, using the method of dropped days and a mean interval of 27·31 days, gave a peak averaging 0·03″ above the mean level for the 1,230 intervals between 1847 and 1938 inclusive. This peak is found to occur in all parts of the period examined but is most pronounced around 1890. In the solar cycle 1890–1901 it averages 0·054″ above the mean and consequently it is very noticeable.

The peak tends to be of a conical shape and covers about ten days of the graph. This departure from the sine curve appears to denote a complex origin, but a competent mathematician who examined the figures informs me that they are not inconsistent with a real force. On the other hand, the amplitude is about ten times that produced by the moon's tidal forces, and

there seems to be nothing at present known that could account for it.

An examination of the probability of such a peak occurring by chance showed that it was very unlikely, but of course it cannot be a matter of certainty without further supporting evidence, which is being sought. It may, however, be said that Mr. F. E. Dixon examined the reported occurrences of aurora in Great Britain for about eighty years, and finds a tendency to periodicity in about 27·3 days[1].

Greenwich records go back long before 1847, but the barometer was not then read on Sundays and holidays; this introduces a further factor of uncertainty, and it was not considered that results obtained in these circumstances would be of sufficient value to justify the work involved.

The near approach of 2,731 days to a definite factor of 274 months makes some relation with Dr. Abbots' work a possibility, and from internal evidence, such as occurs when carrying out an extended analysis of this kind, I believe that there is some probability that further examination of the data, and other meteorological phenomena, may show that it is not another manifestation of the vagaries of chance.

W. R. PRISTON.

10 Salisbury Road,
Edinburgh, 9.
August 3.

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Condensation of the Hexapeptide Ester of Glycine into the 96- and Higher (3×2^n) Peptide Esters

FOR a long time it has been known that heating under various degrees of the ester of glycine[1], glycylglycine[2] and diglycyl-glycine[3] results in the formation of certain condensation products with liberation of alcohol. If the hexapeptide ester of glycine would undergo the type of condensation exhibited by the dipeptide ester, then the simplest model of a 'cyclol 6' postulated by the Wrinch theory[4] could be prepared. The formation of such 'cyclo-hexapeptide' of glycine could then be considered as evidence for the hexagonal folding by hydrogen bonds of the polypeptide chains.

Experiments were carried out by heating the pure hexapeptide ester at a constant temperature (102° ± 1°) and samples were withdrawn for methoxyl estimation at certain intervals of time. It was found that, instead of cyclization, the hexapeptide ester underwent the type of condensation characteristic of the tripeptide ester in a series of subsequent bimolecular reactions yielding the 12-, 24-, 48-, 96-peptide (3×2^n peptide) ester of glycerine with a calculated methoxyl content of 4·33, 2·21, 1·12, 0·56 per cent and (0 per cent), respectively. When n was limited to 4 (OCH_3, 1·12 per cent) the average rate of the reaction, with the hour as the unit of time, was $10^4 K = 150$, calculated from the methoxyl content of the samples. At a temperature 10° higher, the rate of condensation was 3·7 times faster, corresponding to an activation energy of about 38 kcal. When the hexapeptide ester was heated at 130° ± 1° for six days, the methoxyl content (0·58 per cent) indicated the presence of the 96-peptide ester of glycine with the empirical formula of $C_{193}H_{293}O_{97}N_{96}$ and a molecular weight of 5504. From the nature of this type of condensation reaction, it follows that the reaction products necessarily represent a mixture of polypeptide esters. Such mixtures cannot be separated by chemical or simple physical methods.

In order to prove, first, that a hexapeptide ester does not combine with a tripeptide ester, and secondly, that the reaction products do not consist of mixtures of 'cyclol 6' and unchanged starting material, samples of diglycyl-glycine methyl ester were heated at 100° for different lengths of time and then analysed. The methoxyl content of the insoluble residues clearly indicated that, after two hours of heating, the tripeptide ester gave rise to almost pure dodecapeptide ester (found, OCH_3, 4·1 per cent; calc. OCH_3, 4·3 per cent) as the highest condensation product, and neither nonapeptide ester nor 'cyclol 6' was formed during the reaction.

All the polypeptide esters of glycine obtained in the present work are colourless substances of amorphous appearance, insoluble in alcohol but slightly (0·1–0·5 per cent) soluble in cold water. They all give the biuret reaction very strongly and dissolve completely in cold concentrated hydrochloric acid, but only partly in dilute alkali solution. They are strongly reminiscent of denatured proteins, and like many of the latter substances they are soluble in concentrated urea solution.

Although the inability of the hexapeptide ester of glycine to form a 'cyclol 6'-peptide by this method would seem strongly to favour the conception of unfolded polypeptide chains, yet, the important fact must not be overlooked that the tetrapeptide esters do not undergo[5] any type of condensation at all. This would indicate a fundamental difference between the shape of the molecules of the mono-, di-, tri- and 3×2^n-peptide on one hand, and that of the tetrapeptide and probably of the penta-, hepta-, etc., peptide on the other.

An extensive investigation by application of both chemical and physico-chemical methods is being started in this laboratory. A detailed account of the present work will be published elsewhere.

Acknowledgment is made to Dr. S. M. Trister, research assistant in this Department, for the numerous methoxyl estimations carried out in this investigation.

EUGENE PACSU.

Frick Chemical Laboratory,
Princeton University,
Princeton, New Jersey.
July 5.

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Catalase

Sumner and Dounce[1] have recently observed that on splitting with acids crystalline ox liver catalase yields a 'blue substance', which remains in the aqueous acetone mother liquor after the hæmin crystals have come out. This mother liquor contained approximately the same amount of iron as the hæmin crystals. The authors concluded from these observations that catalase has two bile pigment hæmatin groups in addition to two protohæmatin groups in a molecule of the weight 248,000, and that the blue substance, though not identical with the original prosthetic group in catalase, still contains iron and differs from biliverdin.

The blue-green pigment has been previously isolated by Stern[2] from horse liver catalase preparations and has been identified by Lemberg (cf.[2]) as biliverdin (dehydrobilirubin). We have now isolated crystalline biliverdin hydrochloride from a crystalline ox liver catalase of the catalase-factor 31,000, prepared by the method of Sumner and Dounce. To 25 c.c. of the catalase solution 50 c.c. of glacial acetic acid were added and the green-blue solution was poured into 300 c.c. of peroxide-free ether. After shaking with a few drops of saturated sodium acetate solution, the ether solution is poured off from the denatured protein which remains only slightly coloured. From the washed ether solution 5 per cent hydrochloric acid extracts iron-free biliverdin hydrochloride, which soon precipitates. Recrystallization from a mixture of methyl alcohol and aqueous hydrochloric acid yields the typical straight, fine needles of biliverdin hydrochloride. The compound was also characterized by transformation with zinc acetate and iodine into the biliviolin zinc complex, which possesses a typical absorption band at 637 mμ.

In a paper[3] probably inaccessible to the American authors, I have already brought forward spectroscopic evidence that biliverdin does not occur in catalase as such, but is liberated by acid from a bile pigment hæmatin-protein. One would, therefore, expect that the mother liquor of the hæmin crystals contains iron in addition to biliverdin. The preparation described above shows that iron and bile pigment are no longer combined after the treatment with acid, and that the 'blue substance' is biliverdin.

Sumner and Dounce based their conclusions as to the number of bile pigment hæmatin groups in the molecule on the equal division of iron between the hæmin and the blue mother liquor. It is, however, difficult to free catalase from an accompanying iron protein compound[5] and from inorganic iron. Keilin and Hartree[4] claim to have obtained a horse liver catalase preparation with a ratio total iron to hæmatin iron as low as 1·2. We have, therefore, studied whether there is a constant ratio biliverdin to hæmatin after acid splitting. Horse liver catalase was prepared by the method of Agner[5] followed by crystallization as described by Dounce and Frampton[6] and also by the method of Keilin and Hartree[4]. 0·5–3·0 c.c. of the catalase solutions were treated as described above. The biliverdin hydrochloride was determined colorimetrically with a standard of pure biliverdin hydrochloride; the hæmatin was determined spectrophotometrically as pyridine-hæmochromogen after extraction from the ether by dilute ammonia. 60–70 per cent of the total catalase hæmatin was thus recovered. With all crystalline preparations and in the great majority of less pure catalase preparations from ox and horse livers, the ratio biliverdin to hæmatin was close to 1 : 3. While the fractionated ammonium sulphate precipitation of Agner removed much of the accompanying iron protein, the biliverdin-hæmatin ratio remained quite unaltered. It seems also significant that only one preparation of horse liver with an abnormally low biliverdin content (biliverdin-hæmatin ratio 0·15) had an abnormal quotient activity constant over hæmatin iron ($k/F_{ep} = 770$, while we found normally 2,300). While these observations support the claim of Sumner and Dounce that bile pigment hæmatin is an essential part of the enzyme molecule, they indicate that catalase contains one, rather than two, groups of bile pigment hæmatin and three, rather than two, groups of protohæmatin. The hæmatin content of our purest ox liver catalase preparation was indeed 0·73 per cent (2·8 mol. hæmatin per molecule).

This conclusion is supported by a quantitative spectrophotometric study of the pyridine-hæmochromogen obtained from catalase. The band at 650 mμ [3] accompanying the protohæmochromogen bands is no longer observed after acid splitting and is, therefore, that of a bile pigment hæmochromogen similar to verdohæmochromogen. Its maximal extinction is only about a quarter of that of the first protohæmochromogen band at 557 mμ, while the maximal absorption of pyridine-verdohæmochromogen is more than half as high as that of this band. Although the identity of the bile pigment hæmatin in catalase with verdohæmatin is not yet established, it is very likely that the maximal absorption should be rather similar.

Since Keilin and Hartree[4] have shown that catalase undergoes reduction to the ferrous form during its action on H_2O_2, and since ferrous hæmatin compounds are easily oxidized by H_2O_2 to bile pigment hæmatin[7], it might be assumed that the bile pigment hæmatin arises during the action of the substrate on the enzyme. We have, however, failed to discover any evidence of an increase of the amount of biliverdin obtained by splitting, or of the absorption maximum at 650 mμ, subsequent to a prolonged action of catalase on its substrate.

The bile pigment hæmatin is, therefore, an essential part of the catalase molecule. The impossibility of splitting catalase reversibly into protein and prosthetic group is now explained by the lability of this prosthetic group to acid.

This investigation was carried out under a grant of the National Health and Medical Research Council of Australia.

R. LEMBERG.
M. NORRIE.
J. W. LEGGE.

Institute of Medical Research,
Royal North Shore Hospital,
Sydney.
July 25.

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Growth of the Mandible in the Pig

GROWTH of the mandible has been a controversial problem since the days of John Hunter, notwithstanding that he, John Tomes the elder and George Humphry in turn performed crucial experiments which showed that growth took place at the posterior border of the mandible and absorption at the anterior border, thus providing room for the eruption of the developing permanent molars.

Radiographic examination of a 'runt', the small starveling pig, shows evidence of arrested growth in the skeleton. In the scapula (Fig. 1) the successive checks to growth are displayed by lines of arrested growth, along which bony deposition is well marked. The lines are best seen at the vertebral border of the scapula, particularly at the postero-inferior angle. These lines of arrested growth have been studied in detail by me[1] in the long bones of children.

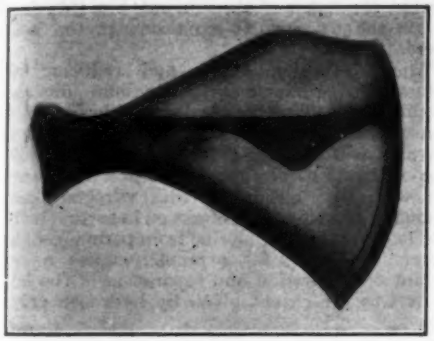

Fig. 1.

RADIOGRAPH OF THE LEFT SCAPULA OF A YOUNG PIG SHOWING LINES OF ARRESTED GROWTH AT THE VERTEBRAL BORDER.

In the mandible of this pig (Fig. 2) the lines of arrested growth are well marked at the posterior border, at the insertion of the temporal muscle on the coronoid process, and at the superior and posterior border of the condyle. These are the sites of alternating active growth and arrested growth.

Lines of arrested growth are absent from the anterior border of the mandible and coronoid notch. These are the sites of active absorption of bone.

The third molar, at present buried in the mandible, will erupt later by reason of the upward movement of the crown consequent upon the growth of the roots, but it will also be uncovered and laid bare by the absorption of bone at the anterior border of the mandible.

This radiographic proof of the accuracy of John Hunter's description of the growth of the mandible is in accord with the recent descriptions of madder-fed pigs by Brash[2].

The radiograph of the mandible also shows the danger, in the animal or person who is not fully grown, of making a forecast as to whether an unerupted wisdom tooth (third molar) will or will not erupt satisfactorily at a later date. Until growth in the mandible ceases at 21–25 years of age in the human, female or male, there is little justification for interference with a third molar which gives rise to no active symptoms. On the other hand, the continued refinement of the face and reduction in the size of the mandible in passing from ancient man to modern man suggests that the wisdom tooth in the future will give rise to more anomalies than in the past.

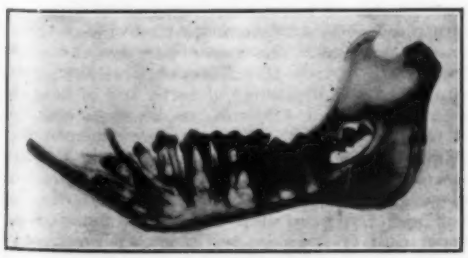

Fig. 2.

RADIOGRAPH OF THE RIGHT HALF OF THE MANDIBLE OF THE SAME PIG IN WHICH THE NORMAL SITES OF GROWTH SHOW DENSE BONY LINES OF ARRESTED GROWTH, AND THE SITES OF ACTIVE ABSORPTION SHOW NO SUCH LINES.

H. A. HARRIS.

Anatomy School,
University of Cambridge.

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Production of Intercellular Hormones by Mechanical Injury

PREVIOUS papers from this laboratory have demonstrated the production of proliferation-promoting factors (intercellular wound hormones) by cell aggregates subjected to lethal ultra-violet or X-rays[1], heteroauxin[2], and carbon dioxide[3]. These factors are evidently produced by living cells as a response to injury, since the maximum production of the hormones precedes the maximum rate of killing[3].

It has been of interest to determine whether mechanical injury would also lead to the formation of these factors. Yeast suspensions in isotonic salt solution were subjected to several types of mechanical agitation. These included various shaking devices and the rotation of bottles of the suspensions on a wheel. Very low killing of the cells was observed, and the cell-free fluids from the suspensions had slightly greater proliferation-promoting activity than the unshaken controls. The degree of increase in activity was usually small and the results were subject to considerable variation. The addition of glass beads to the suspensions in the rotating bottles gave cell-free fluids of very high activity. However, although very few intact cells were killed, many cells were completely disintegrated. It was therefore uncertain how much of the increased activity was due to intercellular hormones and how much to cellular disintegration products.

The following procedure was finally adopted. The yeast was agitated by placing it in a stoppered glass tube $1\frac{1}{8}$ in. $\times$ $3\frac{3}{4}$ in. attached to the voice coil of a loud speaker, the cone of which was in the horizontal plane. The voice was actuated by a beat-frequency audio oscillator and audio amplifier. In the experiments reported, the voltage across the coil varied from 1 to 4, corresponding to a power input of 0·1–1·6 watts. A vibration frequency of 50 cycles was employed. Three and one half to 7 gm. of crumpled cake yeast were placed in the tube and vibrated for 5 hours. After the addition of 35 c.c. of isotonic sodium chloride solution the vibration was continued for another hour. Preliminary experiments showed this treatment to be more effective than vibration of a suspension for the whole period. The growth potencies of Berkefeld filtrates of the suspensions were compared with those of controls which were treated in the same way except that vibration was omitted. In later experiments increased potency was obtained by adding sand to the yeast during agitation. This did not markedly increase the amount of killing as determined by methylene blue staining, nor was fragmentation of the cells observed. About 25 per cent of the cells were killed. The experimental filtrates were one and

one half to two and one half times as potent as the controls on a volume basis, and one and one half to four times as active on the basis of equal weights of solid in the filtrates.

Preliminary experiments indicate that the active materials, like those from ultra-violet injured yeast cells[4], are characterized by ultra-violet absorption at 2600 A.

JOHN R. LOOFBOUROW.
ELTON S. COOK.
SISTER CECELIA MARIE DWYER, S.C.
SISTER MARY JANE HART, O.P.

Institutum Divi Thomæ,
Cincinnati, Ohio.
July 21.

[1] Fardon, Norris, Loofbourow and Ruddy, NATURE, **139**, 589 (1937); Sperti, Loofbourow and Dwyer, *ibid.*, **140**, 643 (1937); *Studies Inst. Divi Thomae*, **1**, 163 (1937); Fardon, Carroll and Ruddy, *ibid.*, **1**, 17 (1937); Loofbourow, Dwyer and Morgan, *ibid.*, **2**, 137 (1938).

[2] Loofbourow and Dwyer, *Science*, **88**, 191 (1938); *Studies Inst. Divi Thomae*, in the press.

[3] Loofbourow and Dwyer, NATURE, **143**, 725 (1939).

[4] Cook, Loofbourow and Stimson, 10th Internat. Congress of Chemistry, Rome, May 1938; Loofbourow, Cook and Stimson, NATURE, **142**, 573 (1938).

Exfoliation of Vermiculite by Chemical Means

SPECIMENS of vermiculite from different localities have been examined in the laboratories of the Mineral Resources Department of the Imperial Institute in the course of an investigation into possible Empire sources of supply, and an interesting phenomenon has been observed in connexion with the expansion of the mineral, a property on which its commercial value depends. This expansion is usually brought about by heating the material, and a record of an instance in which it has been effected by chemical treatment appears to be of scientific interest.

It has been noticed that in the mechanical analysis of soils, the preliminary treatment with hydrogen peroxide causes some alteration in the appearance of weathered mica particles present in the soil. This suggested that hydrogen peroxide might have some action on vermiculite, and in order to ascertain its effect a number of small pieces of the mineral, about ¼ inch in diameter and less than 1/10 inch in thickness, were covered with the reagent (20 vol. strength) and allowed to stand. Complete exfoliation takes place after some time in the cold and can be hastened by gentle heating. A preliminary drying of the mineral at 100° C. was found to accelerate the action in one instance. The treated specimens have a concertina-like appearance, the lamellæ forming the bellows, and with one specimen alternate light and dark coloured zones were observed parallel to the direction of expansion, which is curved. The material treated with hydrogen peroxide is of a paler colour than that exfoliated by heat, and provided that it is kept moist, is also very soft, requiring only gentle rubbing or stirring, rather than grinding, to reduce it to a fine state of subdivision. The mechanical strength of the treated and still moist product is low, but after drying in a steam oven, its properties are similar to those of the heat-treated material.

The exact cause of this effect has not yet been ascertained. It has always been considered that the exfoliation of vermiculite on heating is due to the separation of individual lamellæ by the evolution of combined water, but this would not explain the similar effect obtained with hydrogen peroxide. The effect obtained may possibly be due to evolution of oxygen between the flakes of the mineral, but this does not explain the asymmetric expansion or the zones of different colour.

Various other oxidizing and reducing agents (potassium permanganate, potassium dichromate, chromic acid, sodium hypobromite, chlorine generated from permanganate and hydrochloric acid, water saturated with sulphur dioxide) have been tried, but none of them has given an expansion at all comparable with that obtained with hydrogen peroxide, although some effect was observed in certain instances after long standing. Chlorine from permanganate and hydrochloric acid, for example, causes a certain amount of exfoliation and separation of the lamellæ but not to the extent given by hydrogen peroxide.

R. C. GROVES.

Mineral Resources Department,
Imperial Institute,
London, S.W.7.
August 16.

Technique of the Painting Process in the Bagh Caves in Gwalior State

THE Bagh caves (lat. 22° 22′ N., long. 74° 48′ E.) are situated among the southern slopes of the Vindhya Hills, seventy miles from Mhow, a town on the Rajputana-Malwa section of the B.B. and C.I. Railway. The caves were at one time fully decorated with paintings. But there are remains of them[1] only in caves III and IV. The caves, which are of sandstone, have crumbled, due to the excessive weight of the superimposing band of claystone with moisture percolating through it. Consequently many of the paintings have disappeared. The paintings probably belong to the early seventh century A.D.[2], being contemporaneous with the paintings in Caves XVI and XVII at Ajanta.

The paintings of Bagh and Ajanta form a class by themselves. They belong to the golden age of Indian classical art, which inspired more than half the art of Asia. They will bear comparison with the best that Europe could produce down to the time of Michelangelo[3].

In the course of my studies[4] on Indian paintings, I recently investigated the methods and materials used by the classical artists at Bagh. The paintings are done on the sandstone wall of the veranda lining Caves IV and V. The painted stucco consists of rough plaster of ferruginous earth or of lime. The earth plaster has a thin smooth coat of a mixture of gypsum and lime. The lime plaster has a thin coat of limewash. These thin coats support the layer of paint. The rough plasters of earth and of lime vary in thickness from 7·9 mm. to 20 mm. and from 3·4 mm. to 6·5 mm. Their average thicknesses are 17 mm. and 4·9 mm. respectively. With the earth stucco, the gypsum-lime layer and the paint layer are each 0·1 mm. thick. In the lime stucco, the limewash and the paint film are each 0·2 mm. thick. 48 per cent of the deep red plaster is composed of particles the sizes of which vary from 200 μ to 700 μ, while 16 per cent of them are less than 200 μ and 36 per cent greater than 700 μ. The corresponding figures for the light red earth plaster and the lime plaster are 40, 20, 40 per cent and 40, 60, 0 per cent respectively.

The results of analyses of the rough plasters are as follows :

	Earth plaster Deep red Per cent	Earth plaster Light red Per cent	Lime plaster Per cent
Moisture	0·27	0·42	0·91
Carbon dioxide, CO_2	1·25	0·65	12·68
Combined water and organic matter	0·55	1·03	9·34
Silica, SiO_2	87·22	87·10	51·18
Iron, Fe_2O_3	6·12	3·11	2·23
Alumina, Al_2O_3	0·44	5·29	
Phosphoric acid, P_2O_5	0·12	0·10	
Titanic acid, TiO_2	0·09	0·07	
Lime, CaO	2·11	0·75	22·41
Magnesia, MgO	0·56	0·44	nil
Manganese, MnO	0·75	0·39	nil
Sulphuric anhydride, SO_3	nil	nil	0·04
Alkalis	0·44	0·62	1·21
Nitrogen	0·13	0·09	nil

The consolidation of the earth plaster is due to the plasticity of clay[5] present in it. It has also been reinforced and bound with vegetable fibres[6]. The firmness and strength of the lime plaster is due to the lime present and to the considerable quantities of long vegetable fibres originally added.

The pigments employed at Bagh are yellow and red ochres, carbon, lime and gypsum, terre verte and lapis lazuli. Animal glue has been added to the pigments to serve as the binding medium on the earth plaster, while the pigments have been employed in *lime medium* on the lime plaster.

Full details of the investigation will be published elsewhere.

S. PARAMASIVAN.

Chemical Laboratory,
Government Museum,
Madras.
July 5.

[1] Rowland, Benjamin, and others, "The Wall Paintings of India, Central Asia and Ceylon" (Merrymount Press, Boston, 1938), 79–81.

[2] Marshall, Sir John, and others, "The Bagh Caves" (India Society, London, 1927), 22.

[3] *Ibid.*, 4–5.

[4] NATURE, **137**, 867 (1936); **139**, 114 (1937); **140**, 198 (1937); **142**, 757 (1938). Technical Studies (Harvard University), **5**, 221–240 (1936–37): *Proc. Ind. Acad. Sci.*, **7**, 282–292 (1938).

[5] Searle, "The Chemistry and Physics of Clays and other Ceramic Materials" (London: Benn, 1924), 262–63.

[6] "Encyclopædia Britannica", 14th edn., **18**, 39–40.

Points from Foregoing Letters

R. S. Krishnan and D. H. T. Gant have bombarded silver with deuterons from a cyclotron. They find a negative electron activity of period 2·4 min. Chemical separation of the irradiated silver into silver and cadmium fractions has been carried out. The cadmium fraction contains a body of 6·8-hr. period emitting soft negative electrons, possibly due to a cadmium isotope; the silver fraction contains a body of 26-min. period emitting positrons. N. Feather has confirmed some of the previous workers' findings, using the method of critical absorption.

A group of Japanese workers report on their investigations on the fission of thorium by neutrons. They bombarded thorium nitrate with fast neutrons for periods of one to five hours and attempted the chemical identification of the radio-elements produced.

D. S. Kothari derives a set of equations connecting the mean life of the meson τ_0, the cosmological constant t_0 and the gravitational constant G.

Experiments with a diode frequency-changer are described by G. F. Gainsborough which demonstrate the linearity of the relationship between the amplitudes of the high-frequency and intermediate-frequency oscillations, thus permitting comparisons of ultra-high-frequency alternating potential differences to be made after frequency conversion. The calibration of the high-frequency attenuator used was shown to be valid at frequencies up to 600 megacycles per second.

H. A. Laitinen and I. M. Kolthoff show quantitatively the disturbing effects of convection currents on diffusion studies with micro-electrodes and indicate the conditions under which theoretical diffusion conditions can be realized in electrolysis with micro-electrodes.

Barometer readings at Greenwich for the last 92 years seem to show a periodic variation with an interval of 27·31 days. A similar tendency has been observed in the reported occurrences of aurora. W. R. Priston suggests this may have a connexion with Dr. Abbots' period of 274 months (NATURE, April 29, 1939) in meteorological phenomena.

E. Pacsu finds that condensation by heat of the hexapeptide ester of glycine gives 12-, 24-, 48-, etc., peptide esters, the number of glycine molecules being expressed by the general formula of 3×2^n. The condensation at 102° proceeds through a series of successive bimolecular reactions with $10^4 K = 150$ and has an activation energy of 38 kcal. Analysis shows that neither 'cyclol 6' nor nonapeptide is formed in the reaction. The substances are reminiscent of denatured protein and give strongly the biuret reaction.

R. Lemberg, M. Norrie and J. W. Legge find that catalase contains one bile pigment hæmatin group, similar to verdohæmatin, in addition to three protohæmatin groups. By splitting with acids, biliverdin is isolated from crystalline catalase. Evidence is brought forward in support of the view that the bile pigment hæmatin is an essential part of the enzyme molecule.

That the sites of active growth and of active absorption of bone are displayed by a radiograph of the lower jaw of a young pig which had grown irregularly is submitted by H. A. Harris. The satisfactory cutting of the wisdom tooth depends largely on the degree of absorption of bone at the anterior border of the jaw.

It has been shown by J. R. Loofbourow and coworkers that proliferation-promoting factors (intercellular wound hormones) are produced by cell aggregates on subjection to ultra-violet light or X-rays, heteroauxin or carbon dioxide. Loofbourow *et al.* have now examined the effect of mechanical injury, in this respect, by subjecting yeast cells to vibration induced by the voice coil of a loud speaker. Increased growth potency of the filtrate was observed in those subjected to agitation compared with the controls.

Miss R. C. Groves states that vermiculite, a mineral used commercially for heat- and sound-insulating purposes, can be exfoliated by means other than the usual dry heat treatment, and records an instance in which the effect is produced by the action of cold hydrogen peroxide.

RESEARCH ITEMS

Excavations at Brundon, Suffolk

THE gravel pit at Brundon, near Sudbury, Suffolk, affording a rare opportunity of examining a true interglacial bed, a research committee was appointed by the British Association for the purpose of its excavation. The actual work of conducting the examination was carried out under the supervision of the committee by J. Reid Moir in 1935–37, by whom a report on the work of excavation and the archæological material has been prepared, while A. Tindell Hopwood has reported on the fossil mammals. (*Proc. Prehist. Soc.*, 5, 1; 1939). The Brundon section, the base of which lies approximately at 100 ft. O.D., is composed of Upper and Lower Glacial deposits separated by fluviatile beds. The geological, archæological and palæontological evidence points to the probability that the basal Boulder Clay at Brundon was laid down by the Upper Chalky Boulder Clay glaciation. The age of the upper glacial deposit remains uncertain; but it may be that of the Brown Boulder Clay of Hunstanton, Norfolk. At the base of the fluviatile gravel (Stratum 3) at Brundon are traces of an ancient land surface, rich in mammalian remains and non-marine Mollusca. At this level occur unabraded and unpatinated flint implements and flakes of Crayfordian types. The evidence of the fossil bones and shells also points to the deposit being of the period named, post-dating the glaciation responsible for laying down of the Upper Chalky Boulder clay, a conclusion supported by the discovery of Baker's Hole type of implements with the unabraded artefacts. The former are patinated, abraded and striated, suggesting that they had experienced glacial conditions before reaching the Brundon ancient land surface. In the fluviatile gravel implements of various ages have been found—Early Clactonian, Early and Late Acheulean, Baker's Hole and Crayfordian. The upper glacial deposits have yielded a few indeterminate flakes only. There is good reason to believe that the climate during the laying down of the fluviatile deposits was warmer than that of to-day, and that the Brundon section represents a true interglacial accumulation, resting upon and surmounted by deposits laid down during a period of extreme cold.

Ancient House Types in Arizona

INVESTIGATIONS by Dr. Frank H. H. Roberts, jun., on behalf of the Bureau of American Ethnology and the Laboratory of Anthropology, Santa Fé, on archæological sites in eastern Arizona, mainly on the ridge of mesas west of Whitewater Creek, near Allantown, in three successive seasons in 1931–33, have produced valuable information relating to one component of the prehistoric sedentary Indian culture pattern, of which that bearing on house-types is now published (Smithsonian Inst. *Bur. Amer. Ethnol., Bull.*, 121, 1939). The remains belong to several stages of the Anasazi cultural pattern. There are traces of Modified Basket-maker, and large ruins represent the Great Pueblo period; but most of the digging was done in Developmental Pueblo remains, in which twenty pit structures with their accompanying granaries and surface shelters, and three unit-type ruins were examined. They clearly show the growth from small single-roomed pit-dwellings, with brush- and plaster-covered truncated pyramidal superstructures, supported by four upright posts set in the floor of the chamber, to above-ground houses with several contiguous rooms, masonry walls, and flat roofs. Correlated with this is the shift in function of the semi-subterranean domicile from secular to ceremonial purposes. This change is accompanied by comparable changes in other features, particularly in the lesser objects of the material culture, such as pottery, stone, and bone implements, which will be considered in a later report. Charred beams indicate by the dendrological method an occupation of the remains excavated extending over a period of two centuries, dated from A.D. 814–1014.

Excavations at Mas d'Azil, France

EXCAVATIONS by Marthe and Saint-Just Péquart at Mas d'Azil, on the left bank of the Arize, although not yet completed, call for an interim report on four seasons' work (*L'Anthropologie*, 49, 3–4, 1939). The stratigraphic evidence reveals three occupations by Magdalenians, separated from one another by sterile layers of soil, varying in depth respectively from 2 metres to 1 metre. The Azilian layer of occupation, however, except for certain traces which the excavators have succeeded in isolating, had virtually disappeared, and with it the neolithic stratum. In a second terrace under examination, the neolithic people had settled on a layer of clay which seals the Magdalenian, no evidence of Mesolithic occupation intervening. At its greatest thickness this neolithic layer is four metres deep, but has yielded little in the way of artefacts. The Azilian finds include three bone harpoons representing the two Azilian types. In the second Magdalenian horizon—the first provided few relics—a quantity of material in bone includes some sixty blade-bones, of which one half were unused while the other half was scored or in many instances engraved with recognizable figures of animals—reindeer, horses, etc., while in a hunting scene are rudimentary human figures. On the right bank in excavations by M. and Mme. Mandement four galleries have been opened up in the cave, of which the existence was previously unsuspected. Of these one was found to be rich in Magdalenian deposits, including some remarkable examples of Magdalenian art, now in the St. Germain Museum.

Elements in Nutrition

A SURVEY of up-to-date knowledge of elements which appear to be essential when present in traces in human and animal foods is given by W. Godden (*J. Soc. Chem. Ind.*, 58, 791; 1939). Copper in small amounts appears to be necessary in preventing anæmia in animals, the food of which nevertheless contains adequate amounts of iron; its role is not concerned with the assimilation of iron but with the mobilization of iron in the body and with the formation of hæmoglobin. Milk is very low in copper as well as in iron, but copper is present in most other foods. Manganese plays no part in hæmoglobin formation, but appears to be necessary for fœtal development. Cobalt is in some cases essential to iron metabolism, and diseases

of farm animals in Australia and New Zealand have shown it to be an essential element in the cure of bush-sickness; traces of nickel may possibly supplement deficiency of cobalt. Zinc does not play any part in iron metabolism; it is present in higher percentage than copper or manganese in human and cow's milk and is a constituent of crystalline insulin. Fluorine is present in bones and the enamel of teeth, but when present in more than mere traces it affects the enamel of teeth; this may be caused by drinking waters containing more than 1·5 parts per million of fluorine. Iodine deficiency has long been recognized as a probable cause of goitre. Selenium is a harmful element, and its presence in soils of the Great Plains of the United States, from which it finds its way into herbage and cereal grains, causes diseases of animals which were formerly regarded as due to the alkali present in the waters of these regions. The paper includes a short bibliography.

Genetics of Man

ONE of the valuable contributions of Mendel was to show that the dominant individuals in an F_2 generation consisted of homozygotes and heterozygotes in a definite ratio. This has now been shown for the first time in man by J. B. S. Haldane and U. Philip (*J. Gen.*, **38**, 193–200; 1939). They have analysed the data of relatives of hæmophilic patients listed in Birch's monograph. From daughters of hæmophilics there were 15 normal and 13 hæmophilics. Twenty-six sisters of hæmophilics were definitely heterozygous and forty-four could have been homozygous or heterozygous. Mathematical analysis shows that these figures are entirely reasonable and in accordance with the expectation that 50 per cent of the sisters of hæmophilics are heterozygous.

Genetics of the Rex Mouse

THE rex mouse has a coat somewhat similar to that of the same character in the rabbit. F. A. E. Crew and C. Auerbach (*J. Gen.*, **38**, 341–343; 1939) show that rex is an autosomal dominant to normal. The caracul coat discovered by Dunn has very similar characters, but the authors show that caracul and rex are not controlled by allelomorphic genes. The similarity in the phenotypical characteristics of rex and caracul suggests that caution is necessary in assuming that parallel mutation in related species lies at the root of phenotypical similarity.

Sterility in *Drosophila melanogaster*

BERG showed that sterility mutations were more frequent in the *X*-chromosome of *D. melanogaster* than in all the other chromosomes put together. S. Prabhu (*J. Gen.*, **38**, 177–191; 1939) has shown that in the *X*-chromosome the vast majority of sterility mutations occur in a small region between garnet and forked on the *X*-chromosome. This region had previously been identified as a locus probably related to sex determination by Goldschmidt and by Patterson and Suche. Whether the region is that of a sex gene is debatable, but the locus may be one containing several allelomorphs of sterility mutations.

The Avian Sternum

LARGELY due to the authority of Rathke and Parker, it is generally stated the avian sternum originates from rudiments derived from the ventral ends of the ribs. This view has not always been received without question, and the other point of view, put forward by Bruch so early as 1852, is that the ends of the ribs only secondarily fuse with the paired sternal plates. The matter has been re-investigated experimentally by Honor B. Fell (*Phil. Trans.*, B, 563; 1939) using as material the embryos of the budgerigar. The sternum originates from paired rudiments which arise independently of the ribs and can be grown *in vitro* apart from either ribs or coracoids. It is suggested that the sternum should be regarded as related to the appendicular skeleton since its rudiments arise in close association with the wing buds. If a single rudiment is grown *in vitro*, it produces a half-keel but set at a wrong angle, and the presence of its fellow of the other side is necessary for the normal development of the keel. Even then, however, its growth-rate is slower than under non-experimental conditions and it never reaches its normal form. For this to occur development must take place with the normal relations of the surrounding tissues undisturbed. The junction of the two sternal plates is not due solely to their own expansion but to their displacement in a median direction.

Giant Fibres in Squids

IT is thirty years ago since L. W. Williams reported the presence of two giant nerve cells in the squid Loligo, but little attention has been paid to this observation since. Now, however, John Z. Young (*Phil. Trans.*, B, 504; 1939) has examined the structure of the nervous system of this animal in detail. It is found that the nerve fibres vary in diameter from 1 μ to nearly 1 mm., so that it is difficult to separate giant fibres from ordinary fibres. The author has paid particular attention to certain large fibres directly concerned with mechanism employed by the animal in shooting rapidly through the water. These fall into three groups, termed those of the first, second and third orders respectively. The fibres of the first order are two in number and arise from a pair of giant cells which may possibly represent the ventral portion of the pericesophageal ring of the ancestral mollusc. Each gives off a single axon which passes backwards to the palliovisceral ganglion, where it fuses with its fellow. Such an axonic fusion is a most unusual feature in animals. Fibres from this union make synaptic contacts with fibres of the second order. The fibres of the third order are syncytia formed by the processes of numerous neurons in the stellate ganglion. They receive numerous synaptic contacts from collaterals from the fibres of the second order. It is suggested that such a system is adapted for producing rapid movements rather than tonus. It is absent in the octopods, where the method of locomotion is entirely different.

Entomogenous Fungi

A RECENT paper by Mr. T. Petch (*Trans. Brit. Mycol. Soc.*, **23**, Pt. 2; July 1939) makes a further contribution to knowledge of the fungi which attack insects. The present paper is one of a series which brings the total number of entomogenous fungi described by Mr. Petch up to 160. It has the usual yield of newly described species, this time nine in number. One of these, *Stemphyliopsis ovorum*, is not strictly entomogenous, but attacks the eggs of a snail in Ceylon. Other new kinds include *Entomophthora reticulata* from Great Britain, but the geographical range of

the new records extends from Mauritius to Florida, and from the Gold Coast to Ceylon. One might, however, express a little disappointment at the provision of the two names *Hypocrella glabrescens* and *Aschersonia fimbriata* for two stages in the life-history of one of the new species. The first name denotes the ascigerous condition, and would seem to be adequate.

Santorin and Crete

N. A. CRITIKOS, of the Seismological Institute of the University of Athens, considers that the key to the downfall of the Minoan civilization in Crete and the "Descent of the Doriens" about the twelfth century B.C. is to be found in volcanic and seismic phenomena (*Bull. Volcanol. Ser.* (II), **4**, 39–49; 1938). Between 2000 and 1500 B.C. it is thought that Santorin was in violent eruption accompanied by earthquake phenomena and sea waves on a large scale and that the original crater was then formed. (A repetition of this for which there are eye-witness accounts took place in September and October 1650.) Nor were Santorin and other areas in the eastern Mediterranean any more quiet in 1220 B.C. In the spring a violent earthquake was felt near Port Said and in the summer a shock was experienced at Wâdi-el-araba. In the spring of 1180 B.C. there were several shocks, including one felt at Jericho. It appears probable that at about this time Santorin again erupted and the sea flowed into the crater forming the large island and ring of small islands now visible. All this would be accompanied by the rain of ashes, sulphurous fumes, earthquakes and sea waves which would reach as far as Crete, destroying property and causing the deaths and injuries of numerous people. Repeated occurrences of this type would profoundly affect the life on the island. Critikos is further of the opinion that these natural phenomena were all part of a prolonged and more profound movement which resulted in the break up of the 'Egéïde', forming the Cyclades, and which had repercussions on the whole of the eastern Mediterranean.

Periodic Comet Tuttle

JEFFERS and Moore observed this comet on August 12d. 11h. 20·2m. U.T. Its position was R.A. 5h. 55·8m., Dec. + 57° 22′; magnitude 18. In the *Handbook of the British Astronomical Association*, 1939, p. 32, there is an ephemeris computed by Dr. A. C. D. Crommelin; the true time of perihelion is 1·1 day later than that assumed by Dr. Crommelin. The positions in R.A. and Declination can be found by multiplying the correction coefficients by 1·1 and applying the results to the ephemeris.

Comet Kamensky

ON July 24d. 22h. 00m. U.T., Kamensky observed a comet. Its position was R.A. 20h. 55·0m., Dec. − 7° 00′. The object was described as diffuse, with central condensation, its magnitude being 7. An orbit has not been computed.

Law of Error and the Combination of Observations

H. R. HULME and L. S. T. Symms (*Mon. Not. Roy. Astro. Soc.*, **99**, 8; June 1939) have developed a method which allows a system of continuous weighting to be found for a series of observations. When a comparison is made between experimental results for the distribution of errors and a Gaussian curve of the same probable error, it is frequently found that the large errors are much more numerous than the normal law indicates. This subject was treated fully by Simon Newcomb more than half a century ago, and quite recently Jeffreys has shown that the normal law is also defective from the theoretical point of view. Another defect of the normal law is that it affords no satisfactory criterion for retaining or rejecting apparently bad observations unless the observer has noted that the observation is not expected to be as good as the others. In the present paper the authors assume that they are dealing with a set of observations which are all of equal weight, so far as the observer knows. The problem is of a twofold nature: (1) the actual error law which best fits the residuals must first be found; (2) the system of weighting which corresponds to this law must then be obtained. Newcomb and Jeffreys have both solved the problem by different methods, and the paper shows that both of these lead to the same result in actual practice. A description of their method of weighting is followed by the results obtained. The residuals chosen for analysis are those found from the measurements of the variation of latitude made at Greenwich with the Cookson floating zenith telescope from 1927 to 1936. The method of weighting described has also been applied to the results of the measurement of parallax. While the improvement in the results of the latitude observations is small it is nevertheless appreciable, and no doubt the method will be applied in other lines of investigation.

A New Member of the Ursa Major Cluster

W. M. SMART (*Mon. Not. Roy. Astro. Soc.*, **99**, 8; June 1939) shows that the star Gr. 1970 (G.C. 17919), apparent magnitude 6·74, spectral type *G* 0, is a member of the Ursa Major cluster. Hertzsprung suggested about seven years ago that the star was probably connected with the cluster, and Smart's calculations substantiate the view. The co-ordinates of the star for 1950·0 are R.A. 13h. 11m. 34s., Dec. + 56° 58′, and the proper motion components are μ_α 0·0135s., μ_δ − 0·035″. The total proper motion is 0·115″ in position angle 107·6°, the probable error of the latter being ± 1·6°, which is derived from the probable errors of the proper motion components. From his values of the co-ordinates of the convergent point Smart finds that the angular distance of the star from the convergent point is 132·3°. The calculated position angle is 99·9°, the difference of 7·7° between observed and calculated being only slightly greater than the largest difference found for stars belonging to the Ursa Major cluster. On the supposition that the star belongs to the cluster the calculated parallax is 0·039″, and the observed value, given in Schlesinger's "Catalogue of Parallaxes", is 0·045″ ± 0·009″. The calculated absolute magnitude is 4·70, which is the normal value for a *G* 0 dwarf, and the calculated radial velocity is − 12·8 km./sec., as compared with − 7·9 ± 0·9 km./sec. according to Moore's Catalogue and − 11·1 km./sec. determined by J. S. Plaskett at Victoria. The close agreement in all cases shows without doubt that Gr. 1970 is a member of the Ursa Major cluster.

INTERNATIONAL CO-ORDINATION OF DOCUMENTATION

THE growing realization on every hand of the importance of documentation to undertakings of every kind continues to be reflected in the attendance, papers and discussions at the International Conferences of the International Federation for Documentation. Founded as the result of an International Conference on Bibliography at Brussels in 1895, the Federation has become the recognized international organization for the discussion and co-ordination of methods and means for making available on demand the recorded facts relating to any and every subject of special study.

Although the Conference held at Zurich during August 10–14 last was one of the smaller so-called conferences of experts, which are held in alternate years between the full conferences of the Federation, some hundred and seventy members attended from seventeen different countries and thirty-nine papers were communicated, larger numbers than at many full conferences of the Federation in its earlier years. In expressing the welcome of the Swiss Government, Vice-Chancellor Dr. Leimgruber referred to the special importance of administrative documentation as a means of rationalization. Dr. Alingh Prius, president of the International Federation for Documentation, in reply appreciated the suitability of Switzerland, with its four languages, as an example of collaboration, and Zurich, as an industrial town, as meeting places for the Conference.

Four subjects were selected for special study at this Conference, and administrative documentation was one of them. In a paper entitled "La documentation administrative en Belgique", M. Daniel Warnotte gave a detailed account of the state of official documentation services in Belgium. He was followed by M. A. B. Boutillier du Retail of Paris, who referred specially to the French decree of 1938 creating a national centre of documentation at the Bibliothèque nationale for co-ordinating the whole of French administrative documentation. In his paper, "Notice sur l'unification des methods de classement dans les administrations publiques Belges," M. O. Molle of Brussels stressed the importance of the general adoption of a standard system of classification.

A typical paper was that by MM. E. Mathys, E. Rickli, C. Frachebourg and R. Calame of Berne, entitled "La documentation dans les Administrations Suisses des Chemins de Fer Federaux, des Postes, Telegraphes, Telephones et des Douanes," which gave a striking account of the advantages of co-ordinating the work of a number of administrative libraries. Documentation proceeds from the need of an organization to put in order the processes of collecting, abstracting, preserving and supplying books, articles, data, reports, public documents and archives. It has taken a long time to realize that, when such documents are properly collected, abstracted and made available, they are capable of affording invaluable assistance in administration. The existence of the gap between the making of a record in any sphere of work and the placing of that record in the hands of the individual who may need it, is proved by the number of individuals who set themselves to make notes of information that may be useful to themselves. There is as great a step between this and the creation of a special organization for the purpose, as there was for our ancestors, when they decided to give up baking their own bread and to let the baker do it for all. For good or for evil, the need has brought the means, and documentalists, like the bakers, have come.

The medium for distributing the records of progress is the periodical press, but it speaks in so irregular and incoherent a manner that it is impossible, without documentation, to obtain a clear and concise view of any particular branch of knowledge. Documentation is the remedy for the disorder that reigns in the production of documents. It enables a small country like Switzerland to avail itself of advances in knowledge and experimental results from all parts of the world.

In Switzerland, besides the National Library, there are some forty-nine libraries belonging to the Federal administration. The highly favourable results of co-ordinating the work of four of the larger of these libraries, namely, these of the Swiss Railways Department, the Post Office, the Telegraphs and Telephones Department and the Customs Department, has led to the serious consideration of a scheme for the co-ordination of all the administrative libraries in the country. For these four libraries, the acquisition, care and manipulation of books and periodicals is centralized in one library. Thus all the material of documentation, within the scope of the administrations concerned, is collected and dealt with in one place according to the best principals of librarianship and documentation. Each official knows where to go without delay for his material and information. Purchases are made systematically, without duplication. There is economy of cost, staff, furniture, apparatus and material. A community of work between the libraries is recognized, about which there is constant consultation, mutual advice and help. Each library retains its own special character and borrows books freely, as required, from the associated libraries. Periodicals pass from one library to another, or to local branches, sometimes at the rate of thirty an hour.

Since officials usually require documents relating to a particular topic rather than by a given author, a subject catalogue is needed, which must be very minutely subdivided. The Universal Decimal Classification has been adopted by all four libraries as being the most appropriate, thus becoming the basis of mutual co-operation. There are also author and various special catalogues.

In recent years the Swiss Government has realized the inefficiency and costliness of making a documentation of each subject as it arises, and a central documentation service has been organized for these Departments. Periodicals necessarily form the basis of this service. As these come in, data and other useful information are abstracted from them and entered on cards, which also are classified by the Decimal Classification. The cards are retained by the individual libraries, the Post Office having

10,000, the Telegraphs and Telephones centre 80,000 and the Railway Department 200,000. Mutual interchange is facilitated by the utilization of standard methods. The good results obtained could not have been achieved otherwise than by such a rationalization and are such that the same principles are likely to be extended to all the Swiss administrative libraries.

The Section devoted to the Division of Work between Libraries and Documentalists attracted some very interesting papers. Mr. A. B. Berthold gave a survey of work on Union Catalogues in the United States in a paper entitled "Union Catalogues and Documentation". There are now forty-six such catalogues in various stages of completion in the United States. One is national in scope, with approximately 10,000,000 cards; 22 catalogues relate to library holdings in various regions; and 23 are devoted to works in large subject groups. The Federal Government's policy of providing free labour has been the chief factor in their growth, and microphotography has become the unchallenged basis for all such work. Besides indicating the location of books, union catalogues are useful in tending to standardize cataloguing procedure. But, as all such catalogues are arranged under authors, they are unable to provide any answers to inquiries for books on particular topics.

An able paper, "Aufgaben der Bibliotheken in Rahmen der Dokumentation", was contributed by Herr C. Walther of Aix-la-Chapelle. The library problem is to collect systematically the literature within its scope as completely as possible and to make it as fully available as possible to its users. For purposes of documentation, a complete collection of the world's output of useful literature, especially periodicals, is most important. The best aid to users that a library can provide is a complete catalogue of its holdings, with exact information of every part received. A detailed subject catalogue is also necessary. For the utilization of the material in the library, bibliographies and abstracting journals must be added. Since many librarians are born bibliographers, libraries can also serve their users by preparing bibliographies on special subjects within their scope.

In a paper entitled "Bibliotheken und Dokumentation", M. S. Dahl of Copenhagen stressed the need of the investigator for efficient documentation, and showed the difficulty of drawing a sharp line between the work of the librarian and the documentalist. In a similar strain, M. Henri Lemaître of Paris referred in his paper on 'La documentation et les bibliothèques", to the address to the International Committee of Libraries at Brussels last year by M. Marcel Godet, president of the International Federation of Associations of Librarians, who had pointed out the close relationship between the work of librarians and documentalists. Librarians are concerned more with intellectual culture, while documentalists are interested more particularly in utilitarian considerations. Theoretically, documentation includes all, and librarianship is only a part; actually, documentation is a young movement, while librarianship is already full grown and can contribute much to the assistance of documentation.

Mr. Lancaster Jones, London, discussed the part libraries can play in the task of technical documentation, showing how an elaborate organization is needed to discover even the existence of a considerable portion of the world's technical literature. By making its collections as complete as possible within its scope and issuing periodical catalogues, classified by subject, of its accessions, a library can perform an invaluable service to documentation. To this can be added a contribution towards a co-operative scheme for the complete subject-indexing of articles in the periodical literature.

The discussion in this Section led to the conclusion that, while the work of librarians is more passive and that of documentalists more active, no sharp line can be drawn between them, and the solution can be found only through the most complete collaboration.

Space does not permit mention of the papers of equal value that were contributed to the other two sections of the Conference, dealing, respectively, with Documentation in Industry and Photographic Reproduction Methods for Documentation Purposes. The whole are published in a volume and supplement entitled "Rapports: Fédération international de Documentation, XVième Conférence, Zurich" (10 Swiss francs) and obtainable from the International Federation at Willem Witzenplein 6, The Hague, Netherlands. These should certainly be studied by all librarians and documentalists as well as by all those who are interested in the accessibility of information.

Finally, it must be mentioned that not the least factors in the success of the Conference were the delightful hospitality and kindness shown by its organizers.

RHYTHMIC PROCESSES IN BIOLOGY

THE second conference of the Internationalen Gesellschaft für Biologische Rhythmusforschung was held in the "Stads.-en Academische Ziekenhuis" in Utrecht (Holland) on August 25–26. In spite of the international situation the meeting was very successful, and papers were read by members from Holland, Germany, Sweden, Russia and Britain. The German language was used for the most part, but communications were also made in English and French.

The conference was opened by Dr. E. Forsgren, of Stockholm, the president of the Society. On the first day the papers covered a wide range of subjects. Prof. F. Linke (Frankfort) dealt with the different rhythmic processes measured by the meteorologist and which may be important to the biologist. Prof. R. Stoppel (Hamburg) described her work on leaf-movements in plants in relation to time and other factors. F. H. Stieltjes (The Hague) discussed some interesting examples of rhythmic activity. Prof. van der Pol (Eindhoven) considered the mathematical aspects of certain phenomena, and showed by means of a most ingenious electrical model how it is possible to produce artificially the electrical changes associated with normal and abnormal heart beat. K. Mellanby (Sheffield) described the periodic activity of two

insects, the bed-bug and the cockroach, under natural conditions. P. Schoorl (Bennekom) spoke on the curious way in which the rate of increase in weight of pigs fluctuates in an apparently rhythmic manner.

The second day of the conference was devoted mainly to papers dealing with the importance of rhythmic processes in medical physiology and medical practice. Communications were made by Hj. Holmgren (Stockholm), A. Jores (Hamburg), F. Gerritzen (Lunteren), J. Möllerström (Stockholm), Prof. R. Hopman (Cologne), W. Menzel (Tübingen), M. Arborelius (Halmstad), and E. von Philipsborn (Oberstdorf). Lively discussion followed every paper.

It has been arranged that the papers given at the conference will be published in a special supplement to the *Acta Medica Scandinavica*. The future of the Society was discussed at some length. Most of its members are mammalian physiologists or practising physicians, and some zoologists and others were in doubt as to whether their work was of real interest to these medical workers. It was almost unanimously decided that all investigators whose problems dealt with questions of rhythmic activity would be likely to learn a great deal from discussion of each other's work, and it was decided to make an attempt to increase the membership of the Society. It is particularly hoped that more British workers will join; further particulars may be obtained from the secretary, Dr. Hj. Holmgren, Karolinska Institutet, Stockholm.

The local arrangements for the conference were made with great efficiency by Dr. F. Gerritzen of Lunteren, and excursions, dinners, etc., were all greatly enjoyed. Members of all nationalities, including those which are now unhappily at war, were able to discuss their work in a particularly friendly atmosphere.

KENNETH MELLANBY.

PROBLEMS OF GROWTH AND DIFFERENTIATION

AT North Truro, a small village near the extreme end of Cape Cod in Massachusetts, a remarkably successful conference on problems of growth and differentiation was held during August 7–11. Sponsored by the editorial board of *Growth*, members of which also carried out the excellent local arrangements, it brought together about seventy workers from the fields of genetics, embryology, biochemistry, morphology, and botany. Many were accommodated in the wooden cabins of Whitman House, at the edge of a pinewood, not far from excellent sea-beaches, and the delegation from England, at any rate, appreciated to the full the hot weather and the sunshine. The meetings took place in the village school, a building in the attractive wooden New England style, admirably adapted for the purpose. Some informal discussions also took place in the Marine Biological Laboratory of the Lankenau Hospital, about half a mile away.

Each morning and afternoon began with a lecture lasting about an hour, and followed by unhurried discussion and comment. The opening session was devoted to a lively discussion of the proper definitions of growth, differentiation and determination, following a paper on growth and cell-division by Dr. Warren Lewis (Bar Harbor), who illustrated his points by a number of films. In the afternoon Dr. P. W. Gregory (Berkeley) gave an account of the body of work which has shown a relationship between hereditary size in mammals and glutathione content of the tissues, though the connexion does not seem to be so clear in the case of birds. As regards its meaning, an action of sulphydryl groups on synthetically acting proteases seems the most probable hypothesis. The general connexion of –SH and growth or cell-division also came in for discussion.

The second day was given over to the relations between genetics and embryology. In the morning Prof. Curt Stern (Rochester) contributed a masterly description of the present position, dealing with the time of action of genes, dependent and self-differentiation, nuclear induction, etc. He pointed out that dependent differentiation may not always be due to the diffusion of substances; but that in some cases the migration of cells themselves may be involved. Particular interest was aroused by his summary of recent work showing that, in plants also, transplantation experiments reveal nuclear inductors. In the afternoon, Dr. C. H. Waddington (Cambridge, England) took up the story in relation to *Drosophila* development. After making a distinction between form and matter which later gave rise to some argument, he developed the interesting fact that when in a mutant organism, an organ develops in the 'wrong' place, genes which normally act upon such organs can act just as well though the relation of part to whole is abnormal; or in a 'monstrous' part, such as a structure which is proximally a leg and distally an antenna, leg-genes and antenna-genes still exert their characteristic effects. The meeting closed with an animated discussion of the problem whether the 'deployment of competences' of the English school is really the same as the 'segregation of potencies' of the Americans or not.

On the third day, biochemical problems were taken up. Dr. J. Needham (Cambridge, England) described the progress which has been made during the last ten years in our knowledge of the chemical aspects of organizer phenomena. For reasons of time, the discussion was almost entirely confined to the Amphibia. The basic difficulty in these investigations, he said, which had not been at all anticipated at their beginning, is that the competent ventral ectoderm, on which alone the power of a substance to evoke neural differentiation can be tested, itself contains the natural evocator in masked or inactivated form, as can readily be shown by denaturing its proteins in any way and implanting it into another embryo. That adult tissues probably all contain the primary evocator can be shown by the fact that in many cases denaturation of their proteins is not necessary. Recent work on the metabolism of the different regions of the gastrula, which should throw light on the liberation of the primary evocator, was also considered in detail. In the afternoon, the chemical aspects of later growth were described by

Dr. Otto Glaser (Amherst) who introduced the conference to a new method of formulating the growth of organisms and their chemical constituents.

The last full day opened with a highly stimulating paper from Dr. Schotté (Amherst) on regeneration. After briefly reviewing the old question of the origin of the material of the regeneration blastema in invertebrates and vertebrates, he went on to deal with the vexed but important problem of the 'totipotency' of the regeneration blastema in Amphibia. Admitting that limb-competence in the tail-blastema or vice versa has not as yet been definitely proved, he went on to describe his remarkable experiments which indicate that lens-competence, though long absent from the body epidermis, reappears in the material of the tail blastema. It seems also to reappear in regenerating epidermis over the eye. Notochord implanted in tail blastema has also induced pronephric and neural tissue. Should these findings be further confirmed and generally received, a new word will be needed to describe the return of competence after its ontogenetic disappearance. From the floor of the house the word 'recuperation' was suggested, and this seemed to find some favour. In any event, as Ross Harrison has pointed out, there are undeniable instances of reversals of determination, as in tunicates, so the return of competence in vertebrates would not be quite unexpected. The afternoon session on this day was devoted to the studies of Dr. Sinnott (New York) on gene-controlled shape in cucurbitaceous fruits; this led to a vigorous discussion of field-concepts, which had been brewing during former sessions.

On the last morning Dr. Woodger (London) explained the advantages which would accrue to biologists in framing their theories if use was made of logistic technique, of which he gave some examples. He also directed attention to certain points of interest for biological theory which had arisen during the meetings.

On the whole, the meetings were remarkable for the degree of unanimity of thought on fundamental problems which prevailed, as perhaps must be the case when there is enough time to explain individual points of view in a spirit of moderation and candid sincerity. Apart from those who contributed lectures, the discussions were greatly enlivened by the presence of such workers as Dr. Berrill (Montreal), Dr. Hoadley (Harvard), Dr. Thimann (Harvard), Dr. Paul Weiss (Chicago), Dr. Frank Daniel (Berkeley), Dr. Barth (New York), Dr. Reimann and Dr. Hammett (Philadelphia) who showed a film illustrating differentiation and dedifferentiation in Obelia, Dr. L. C. Dunn (New York), Dr. Samuel Brody (Missouri), Dr. Hamburger (St. Louis) and Dr. Frank (New York). At the end of the conference suitable steps were taken to form an organization able to call together similar conferences on growth and differentiation in future years.

TABOO*

THE use of the word 'taboo' in anthropology for customs all over the world, which resemble in essentials the reference adopted from Polynesia, seems undesirable and inconvenient. For such customs the terms 'ritual avoidance' or 'ritual prohibition' are proposed, defining them by reference to two fundamental concepts, 'ritual status' and 'ritual value'. A ritual prohibition is a rule of behaviour which is associated with a belief that an infraction will result in an undesirable change in the ritual status of the person who fails to keep the rule; that is, it involves the likelihood of some minor or major misfortune which will befall the person concerned.

Anything which is the object of a ritual avoidance or taboo may be said to have ritual value. The ritual value is exhibited in the behaviour adopted towards the object or occasion in question—not only in the negative ritual, but also in the positive ritual. A large class of positive rites, those of consecration or sacralization, have for their purpose to endow objects with ritual value.

The word 'value' as thus used always refers to a relation between a subject and an object. It may refer to the act of behaviour towards an object. A social system can be conceived and studied as a system of values. A society cannot exist except on a basis of a certain measure of similarity in the interests of its members. In terms of values the first necessary condition of the existence of a society is that the individual members should agree in some measure on the values that they recognize. To avoid misunderstanding it is necessary to add that a social system also requires that persons should be objects of interest to others.

The study of ritual may be approached by the consideration of the purpose or reasons for the rite, or by a consideration of its meaning. A third method is by consideration of the effects—the direct effect on the person concerned, which may be termed the psychological effect, and the secondary effect on the social structure, the network of social relations binding individuals together in an ordered life—the social effect. By consideration of these we may succeed in defining the psychological function, and in discovering the social function of a rite.

The rites are readily perceived to be symbolic. The immediate psychological effect can to some extent be observed by watching and talking to the performers. The ostensible purpose is present in their minds, but so also is that complex set of cosmological beliefs by reference to which the rite has a meaning. In the performance of the rite the native has made a contribution to the maintenance of the order of the universe, of which man and Nature are the interdependent parts.

Assuming that the act is symbolic, what method, other than that of guessing, is there of arriving at its meaning? We may start with a general working hypothesis that when in a single society the same symbol is used in different contexts, or on different kinds of occasions, there is a common element or meaning, and that by comparing the various uses of the symbol we may be able to discover what the

* From the Frazer Lecture, 1939, by Prof. A. R. Radcliffe-Brown. Cambridge: At the University Press, 1939. Pp. 48. 2s. 6d. net.)

common element is. Thus taking certain customs of avoidance in the Andaman Islands, it would appear that the common element is that the individual affected is in an abnormal ritual status and is likely to suffer some misfortune unless certain prescribed ritual precautions are observed, such as the avoidance of certain foods, while friends or others avoid the use of the individual's personal name. By means of these taboos the occasion acquires a certain social value. But while these rites give men confidence, comfort, and a sense of security, they might equally cause fear, that is, from black magic or spirits. It is largely by the sharing of hopes and fears that human beings are linked together in temporary or permanent associations.

The symbolic rites of the Andamanese are the obligatory recognition of a standardized symbolic form of the significance and importance of the event to individuals and the community at large. They serve to fix the social value of occasions of this kind. So with the food taboos, they attach a definite social value to food, and it is in the activities connected with the getting and consuming of food, with their daily instances of collaboration and mutual aid, that there continually occur those inter-relations of interests which bind the individual men, women, and children into a society. This may be generalized under the formulation that the primary basis of all ritual, and therefore of all religion and magic, is the attribution of ritual value to objects and occasions which are either themselves objects of important common interests linking together the persons of a community or are symbolically representative of such objects.

ECONOMIC BOTANY IN THE TROPICS

SIR FRANK STOCKDALE, in his interesting address, on "The Application of Economic Botany in the Tropics", which had been prepared for the Dundee meeting of the British Association but was not delivered owing to the cancellation of the meeting, points out that many of the economic crop plants now commonly grown in the tropics were distributed when new lands were discovered in Elizabethan times. Tobacco, for example, from tropical America; sugar cane and the banana from the Old World; cacao from Central and South America, and rubber from Brazil. Coffee is indigenous in tropical Africa, and China and Cochin China appear to be the original home of the citrus group.

Following early haphazard distribution came the introduction of Cinchona to India by Markham and Ledger and of rubber to Ceylon by Wickham, both through the auspices of the Royal Botanic Gardens, Kew.

The introduction of coffee to Ceylon and the outbreak of coffee-leaf disease there resulted in arousing scientific interest in tropical crops. Had Marshall-Ward, who went out to investigate the disease, had available the important research work on the rooting systems and the effect of light on the stomatal mechanism in *Coffea arabica*, which Nutman has recently done at Amani, it is possible the Ceylon coffee industry might have been saved.

The West Indian sugar cane industry was similarly faced with disaster through disease, but, thanks to the work of Harrison and Bovell in raising seedlings from different varieties of *Saccharum officinarum*, new types—'noble canes'—were introduced and disease-resistant strains raised. This work, continued by Barber at Coimbatore, India, has been carried on successfully there under Venkataraman and by the Dutch workers in the Netherlands East Indies. *S. spontaneum* has been used in crossing, as well as other allied species, and valuable canes have resulted, notably the well-known *P.O.J.* 2878 which came from a third 'mobilization' of *S. spontaneum*. Types of cane suitable for different types of soil have also resulted from these cross-breeding researches.

Sir Frank then deals with the cotton crop and the valuable work which has been done in Egypt, the Sudan, India and the United States, etc., which have resulted in marked improvements in yield, lint length and fineness, and strength of lint, while disease resistance has also received much attention with valuable results.

Both Cinchona and rubber have been subjected to careful scientific investigation which has led to the recognition of high- and poor-yielding strains, and the selection of high-yielding 'mother-trees' for budding. Hybridizing work on rubber is now being carried out and a search is being made also for strains resistant to the Oidium mildew which is causing serious damage to rubber in the East.

The work now in progress in Trinidad with cacao is fully dealt with and the important discovery of incompatibility in cacao is referred to. Unfortunately it has now been found that some of the best yielding strains are self-incompatible, which upsets some of the earlier work, though the discovery has enabled the work to be prosecuted on fresh lines.

Sir Frank finally deals with the work that is in progress in the improvement of rice and other crop plants and with the work at Amani on raising strains of Cassava immune to mosaic disease.

He concludes with the following very apposite remarks:

"The breeding of resistant forms is the most effective method by which to overcome the difficulties facing producers, and co-operative work by plant breeders and pathologists is required if a satisfactory solution of the present-day problems is to be found.

"Improved types of crop plants, however, demand higher standards of agriculture and whilst it is to be expected that improvements may be achieved from further collections of wild forms for special breeding work and from the interchange of strains which have already been evolved, sound developments are likely only to be secured by a general advance in methods of husbandry designed to ensure soil conservation and the maintenance of its fertility, and by the adoption of those agricultural systems which are suited to the particular environment. In this field much work still remains to be done and additional teams of research workers with specialized training are required in the approach to the problems which are presented to those who are responsible for the welfare of the Colonial Empire."

SCIENCE NEWS A CENTURY AGO

Steam Navigation to the West Indies

A FURTHER step in the promotion of trans-Atlantic steam navigation was taken on September 26, 1839, when the Government granted a charter to the Royal Mail Steam Packet Company which was formed to connect Great Britain and the West Indies by steam. By a contract made in 1840 with the Admiralty, the Company agreed for the sum of £240,000 per annum "to provide, maintain, and keep seaworthy, and in complete repair and readiness, for the purpose of conveying all Her Majesty's mails, a sufficient number (not less than fourteen) of good, substantial and efficient steam-vessels, of such construction and strength as to be fit and able to carry guns of the largest calibre now used on board of Her Majesty's steam-vessels of war, each of such vessels to be always supplied with first-rate appropriate steam engines of not less than 400 collective horse-power; and also a sufficient number (not less than four) of good, substantial and efficient sailing-vessels, of at least 100 tons burden each".

Climate of Russian Possessions in America

IN a long notice of Von Baer's report on the climate of the Russian possessions in America, the *Athenæum* of September 28, 1839, said: "There is no philosopher of the present day to whom Physical Geography (a branch of knowledge fast rising into vigour) is more indebted than M. Baer. . . . In 1830 the Baron F. von Wrangel, well known for his scientific exploration of the northern coast of Siberia, was appointed governor of the Russian possessions in America. In the course of last year Baron von Wrangel placed at the disposal of the Imperial Academy of Sciences at St. Petersburg, all the papers relating to the north-west coast of America . . . and from these papers the learned academician M. Baer immediately selected the Meteorological Journal for the subject of his comments." The observations were made at New Archangel on the southern Sitka Island (named in some maps Baranov Island) and von Baer made a comparison of the mean temperatures of that place with others in the same latitudes. "As the comparison exhibits in the broadest light that apparently anomalous contrast of climate in which it is the business of the physical geographer to trace the operation of constant laws, we shall here state the problem in the form of an abridged table:

Mean Temperatures

	New Archangel	Middle of the Continent	Nain on coast of Labrador	Bergen in Norway
	Lat. 57° 3 N. Long. 135° 13 W.	57° 108°	57° 61·20°	60·24° —
Winter	34·7°	−4°	−1·2°	36°
Spring	42·2°	27·2°	21·6°	44·6°
Summer	56·3°	66·2°	45·6°	58·5°
Winter	47·8°	30·7°	36°	47·7°

Friedrich Mohs (1773–1839)

ON September 29, 1839, Friedrich Mohs, the German mineralogist, died at Agardo, near Belluno, Italy, at the age of sixty-six. Born at Gernrode in the Hartz Mountains on January 29, 1773, he was educated at Halle and at the Mining Academy at Freiburg, which had been founded in 1765 and of which the famous Abraham Gottlob Werner (1749–1817) was then the inspector and teacher of mining and mineralogy. From Freiburg, Mohs went to Austria to study further and in 1815 became professor of mineralogy at Gratz. In 1817 on the death of Werner he returned to Freiburg as professor of mineralogy, holding the post for nine years, after which he was transferred to the Imperial Academy, Vienna. Mohs was one of the originators of the crystallographic systems. His "Treatise on Mineralogy, or the Natural History of the Mineral Kingdom" was translated into English by William Haidinger and published in Edinburgh in 1825.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:

METEOROLOGICAL OFFICER CADETS (Male) in the Department of Industry and Commerce—The Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin (September 28).

ASSISTANT AIRCRAFT INSPECTOR, Grade I, in the Civil Aviation Directorate of the Government of India—The High Commissioner for India, General Department, India House, Aldwych, W.C.2 (quoting Appointments 5/1B) (October 14).

HEADMASTER OF HARROW SCHOOL—The Chairman of the Governors of Harrow School, c/o G. F. Finch, Clerk to the Governors, 70 Pall Mall, S.W.1 (October 16).

DIRECTOR OF STUDIES for the Anglo-Yugoslav Institute, Belgrade—The British Council, 3 Hanover Street, W.1 (quoting 'Yugoslavia').

REPORTS AND OTHER PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Battersea Polytechnic. Evening and Afternoon Courses and Classes. Calendar for the Session 1939–1940. Pp. 40. Department of Hygiene and Public Health, Calendar for the Session 1939–1940. Pp. 21. 3*d*. Domestic Science Department and Training College, Calendar for the Session 1939–1940. Pp. 36. 3*d*. Technical College for Day Students, Calendar for the Session 1939–1940. Pp. 50. 3*d*. (London: Battersea Polytechnic.) [318

Tuberculosis in Cyprus (Final Report). By Dr. N. D. Bardswell. (Reprinted from *Tubercle*, December 1938, January 1939, Vol. 20.) Pp. 46. (London: John Bale Medical Publications, Ltd.) [19

Iron and Steel Institute. Special Report No. 27: Ninth Report on the Heterogeneity of Steel Ingots. Pp. ix+84+16 plates. (London: Iron and Steel Institute.) [19

Other Countries

Annual Report of the Auckland Institute and Museum for 1938-39. Pp. 42. (Auckland: Auckland Institute and Museum.) [308

Sudan Government: Agricultural Research Institute. Report of the Government Analyst for the Year 1938. (Chemical Section, Publication No. 83.) Pp. 18. (Khartoum: Agricultural Research Institute.) [308

Tanganyika Territory: Department of Agriculture. Entomological Leaflet No. 17: Entomologist's Report, 1938. Pp. 6. (Dar es Salaam: Government Printer.) 6*d*. [308

Tanganyika Territory: Department of Lands and Mines, Geological Division. Bulletin No. 13: Explanation of the Geology of Degree Sheet No. 18 (Shinyanga). By Dr. G. J. Williams and N. W. Eades. Pp. 23+2 plates. (Dar es Salaam: Government Printer.) 2*s*. 6*d*. [308

Colony and Protectorate of Kenya. Forest Department Annual Report, 1938. Pp. ii+36. (Nairobi: Government Printer; London: Crown Agents for the Colonies.) 1*s*. [308

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